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STORAGE

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NATURAL SCIENCE:

A Monthly Review of Scientific Progress.

NOVEMBER, 1892.

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NOTES AND COMMENTS.

Tennyson.

AMID the numerous criticisms of Tennyson's work, there is one aspect which does not seem to have received the recognition it deserves, and which forbids that his recent death should be here passed unnoticed. It is that which has placed him as one of the foremost of English Nature-poets. Tennyson's Nature-touches are well worthy of study, not only for their own intrinsic beauty, but because they are in many ways typical of the limitations, as well as of the strength, of his genius. Other poets may have surpassed him in their depth of insight, or their originality of thought; but as a close and accurate observer of Nature, and as an interpreter of her charms in exquisitely-melodious English, Tennyson stands unrivalled. His works are crowded with allusions to the phenomena of Natural Science, and it is little exaggeration to say that each of them is absolutely perfect. Take, for example, his famous picture of the birth of the dragon fly in "Two Voices":—

> "To-day I saw the dragon-fly
> Come from the wells where he did lie.
> An inner impulse rent the veil
> Of his old husk: from head to tail
> Came out clear plates of sapphire mail.
> He dried his wings: like gauze they grew;
> Thro' crofts and pastures wet with dew
> A living flash of light he flew"

His allusions to birds, especially of those of "the level waste" of his early home on the Lincolnshire coast, show his close familiarity with their cries and habits: his rarer references to "scarped cliff and quarried stone," and to "Oh, Earth! what changes thou hast seen," show his acquaintance with the principles of geology. It is, however, upon his botanical allusions that his fame as a naturalist will

mainly depend, and it is here difficult to select from the crowd of splendid images that rise to our memory. Tennyson's range of botanical observation was wide. He noticed the broad features in the vegetation of a whole hill-side, as how the olive groves "turn all hoary to the wind"; he studied the seasonal variations of a single tree, as of the yew, whose "gloom was kindled at the tips, and passeth into gloom again"; or in the minute coloration of a single flower, as of the "horse chestnut's hectic flush." In our national galaxy of poets we have had probably an unusually large share of Nature-poets, but among them all Tennyson is unique in the closeness of his observation united with the perfect polish of his language. Pope, probably, comes nearest to him in the elaborate care with which his images have been finished, but the classical influences that have moulded the style of the "Essay on Man," prevent its vying in popularity with the purer English of "In Memoriam." Tennyson, again, was as much Wordsworth's superior in the simple beauty and ease of his language, as he was his inferior in his breadth of view and the depth of his philosophy. Both poets were keen observers of Nature, but whereas Wordsworth was a philosopher, Tennyson was —at least in his allusions to Nature—a miniature painter with a consummate mastery of the technique of his art. Hence, while Wordsworth has left a deep and permanent impression on human thought, Tennyson has bequeathed to us a gallery of artistic gems. A comparison of the late Laureate with Goethe is still less in his favour; for whereas many of Goethe's Nature-touches are fully equal to Tennyson's in beauty of thought and expression, the latter has left us none of the important morphological generalisations by which the great German did so much to advance the progress of botanical science.

Tennyson, in fact, was not a great thinker. and the estimate that accepted him as such has long since been discredited: his work is valuable rather as the expression of one popular school of contemporary thought; his poetry will thus be of the highest service to the future historian of the intellectual development of the Victorian era. As Burke said, "the popular orator is the man who is a little, but only a little, in advance of his time." Tennyson's popularity may demonstrate that this maxim applies also to poets. Tennyson was carried away by the wave of scientific progress of the early part of our era; and as he tells us he once nourished

> "A youth sublime,
> With the fairy tales of science, and the long result of Time."

And there were occasions when Tennyson seemed to have grasped the most advanced teaching of his time: the pantheistic conception of the unity of life was never better expressed, even by Goethe, than in Tennyson's "flower in a crannied wall":—

> "Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man "

But it was apparently only "the fairy tales," the sensational conclusions and not the methods of scientific thought, that fascinated him; and when

> "Half the marvels of my morning, triumphs over time and space
> Staled by frequence, shrunk by usage, into commonest commonplace"

the fairy tales lost their charm. Hence his enthusiasm for science soon vanished. "Science grows but beauty dwindles," he laments in one place: "the sun and moon of our science are both of them turned into blood," he protests in another. The astronomy of his early years had resolved the Milky Way, examined nebulæ, and discovered new planets and satellites: these results could appeal to Tennyson's imagination, and he would with pleasure watch

> "the Pleiads, rising thro' the mellow shade,
> Glitter like a swarm of fire-flies tangled in a silver braid."

The astronomy of his old age compelled the light of the stars to deliver their message and tell us of the chemical composition of the heavenly bodies: but it did not interest Tennyson to know that tellurium had been discovered in the stars, for he simply "knew that their light was a lie."

With his loss of interest in the results of scientific research, Tennyson grew intolerant of the school of thought it had established. The man who 50 years before gloried that he was "the heir of all the ages in the foremost files of time," who then cried his loudest

> "Forward, forward, let us range,
> Let the great world spin for ever down the ringing grooves of change,"

now confessed that this was all "the babble of a foolish past,"

> "Fires that shook me once but now to silent ashes fall'n away."

Like Newman, who welcomed the night because he held the daylight "garish," Tennyson felt that scientific progress had only led us—

> "From a cheerless night to the glare of a drearier day,"

and the author of "In Memoriam" could now draw the spiteful sketch of "Edgar" in the "Promise of May," and the burlesque of the monomaniac of "Despair."

Hence the naturalists of the younger generation had sadly learnt to realise that we could expect no more the manly enthusiasm of Tennyson's younger days, and that we must trust "for songs to encourage us not from his lyre." Nevertheless, his poems have always been looked for with pleasure, for even amid the most petulant of his latest lamentations there was sure to be some splendid image, some polished couplet, some echo of the "curlew's call," to remind us that Tennyson was still a naturalist as well as a poet. Hence regret that he did not always "sweep into the younger day" is finally lost in gratitude for the echoes of the birds' songs, the pictures of the flowers, and all the exquisite Nature-touches which he has left to help us "to smell the meadow in the street."

The Crisis in the United States Geological Survey.

Foremost among the news of scientific movements this month must be placed a serious announcement from America. All European students of geology will learn with deep regret that Congress has this year refused the United States Geological Survey its usual appropriation, and that all field work has therefore been suspended, while the members of the staff have been ordered so to finish off their reports that they may either be published or kept in manuscript. As the news first reached England, it seemed as if the final winding up of the Survey were contemplated, but this, there is reason to hope, is not the case. The problems of the geology of the United States are of such wide interest, and they have been handled by the official surveyors with such originality and breadth of view as to have exercised great influence on contemporary geological thought; a complete suspension of the Survey would, therefore, be nothing less than a scientific catastrophe. The study of American geology is attended with such difficulties arising from the vastness of the distances to be traversed, and the unsettled state of the country, that any detailed work is beyond the power of single individuals, and only a great national department could hope to surmount the obstacles. The Monographs and Bulletins issued by the Survey have, moreover, generally been regarded as the finest series of geological works ever published, and the generosity with which they have been distributed to foreign geologists is frequently quoted as an example to European Governments. On this side of the Atlantic it has, therefore, been generally felt that, while many of the United States Departments, such as the Bureau of Statistics, have much to learn before they reach the European standard, the Geological Survey was an institution of which the citizens of the United States might be justly proud.

Bitter attacks have been made on the Survey, such as that which caused a painful sensation in Europe three years ago; but the most venomous shafts of this were obviously inserted by the editors of the papers in which the controversy raged. After deducting the bluff about "hurling azoic facts" and "picking up palæontological gauntlets," the general impression left was simply that two famous palæontologists could not agree as to whether the skull of a certain fossil ought to have been mounted on the end of its neck or on the end of its tail. The speech of Secretary Noble at the opening of the International Geological Congress at Washington last year encouraged the hope that this quarrel had not damaged the credit of the Survey; though we fear it must have had some effect, since the section of Vertebrate Palæontology is no longer to be officially recognised. The Chief Secretary stated that the United States Government fully realised the immense national value of the work of the Survey, and that, large as was the annual appropriation for its service, no grant was voted more readily. We may, therefore, fairly

hope that the recent emphatic contradiction to the statement of the Secretary of the Interior implies no alteration in the recognition of the necessity of a State Survey, but only doubts as to the efficiency of the present Administration.

A national Geological Survey is of course merely supported as a commercial investment; there are no State-supported botanical or zoological surveys, except in so far as forestry and fishery boards may be regarded as such. A nation is, therefore, justified in asking, not how far questions of abstract speculation have been advanced, but as to what progress has been made in the preparation of the maps, for upon these so largely depends the economical working of mines, the development of mineral wealth of newly-settled districts, the determination of the most profitable routes for roads and railways, and the establishment of the best water supply. It is generally recognised, at least on this side of the Atlantic, that the fundamental duty of a Survey is to survey, and that the progress in mapping is the best guide by which those responsible for the expenditure of the public funds can determine whether the nation is getting the best return for its money. Judged by this standard, even the most friendly critic of the United States Geological Survey must admit that it has not done as much as might have been expected. Many most valuable maps have been issued on special subjects, such as those in the Atlases to Emmons' monograph on "The Ore-Deposits of Leadville," to Dutton's "Cañon of the Colorado," and to Hayden's Rocky Mountain Survey, and also the smaller ones scattered through separate monographs, such as in Gilbert's Henry Mts. and Lake Bonneville. Of the general map, however, only one sheet appears to have been issued. This covers the very limited District of Columbia, and it is very doubtful if the scale of coloration could be widely applied. The illustrations which accompany the publications have been more successful, and these are unsurpassed for their educational value and excellence of execution. One cannot, however, but feel that they have sometimes been extravagantly used for subjects of only secondary geological interest. While we have been left uninformed on many points of great interest, such as the Snake River lava flows, we have received such a plethora of illustrations of Pleistocene scenery and Dismal Swamps, that one has been tempted to exclaim, "This is magnificent, but it is not geology."

The Ethnographical branch of the U.S. Survey has also absorbed a rather large share of attention. It is no doubt very pleasing to read the story of "How the black rabbit caught the sun," not only in English but in Cehina; but it strikes the ordinary Briton as rather a curious arrangement for ponderous monographs on the Cehina language to be issued by a Geological Survey, for the language is not even extinct yet. The charge has recently been made against the present Director of the Survey that he has systematically favoured the work of the Ethnological branch, in which he is most interested, at

the expense of the Geological. The pamphlet in which this accusation was made was marked throughout by such bitterness and manifest unfairness, that we should not be disposed to attach much weight to that alone; but we have heard the same view expressed in Europe. So far as Major Powell's writings allow us to judge, he is a daring explorer, and an ardent ethnologist. Both his predecessors, Clarence King and Hayden, made important contributions to geological literature, but the writings of the present Director have not been sufficient to inspire any great faith in his capacity as Director of so difficult an undertaking as the Geological Survey of the United States. There are on the staff men whose names are household words in modern geology, and if, as a result of the forthcoming State enquiry, Major Powell should be retained as head of the departments of Ethnology and Irrigation, and the Geological Survey be separated as a distinct institution, with such a geologist as Dr. G. K. Gilbert at its head, the recent action of the Congress will result in ultimate good to science.

The Australian Barrier Reef.

Since the days when Flinders described the great Australian Barrier Reef in the second volume of his "Voyage to Terra Australis," and King prepared his oft-quoted Admiralty Chart, the reef has always occupied a prominent place in the literature of the Coral question. Owing to its vast extent—ranging 1,200 miles in length—it forms by far the most conspicuous of reefs, ancient or modern. The great size of the lagoon channel, which sometimes amounts to 70 miles in width and 60 fathoms in depth, further gives it an especial interest in connection with the subsidence theory, by which Darwin explained its method of formation; the theory being supported not only by the depth of the lagoon, the great height of its steep seaward face, and the fact that the open ocean beyond is interrupted only by a few small atolls. Nevertheless, in spite of the interest of the reef, comparatively little has been done upon it, mainly, no doubt, owing to its vast size. This is especially to be regretted, as a knowledge of the structure of existing barrier reefs is of primary importance to geologists; for probably most of the fossil reefs, such as those of the Corallian rocks of England, belonged to this class. Moreover, the fascinating problems connected with Darwin's theory have, to a large extent, monopolised the attention of students who have had the opportunity of working on coral reefs, and thus our knowledge of the biological questions connected with them has flagged. The pools and lagoons in coral reefs are exceptionally prolific in life, both animal and vegetable, and offer a most tempting field for work; but, with some few exceptions, such as Dr. Hickson's sojourn on the reefs of Celebes, and Walther's study of those of the Red Sea, this has been neglected.

The recent proposal for the establishment of a biological laboratory beside the reefs of Barbadoes seems to make little progress towards realisation. The announcement that a large monograph upon the Australian Barrier Reef is now in the press is, therefore, very welcome, especially when we know that it comes from the pen of so experienced a zoologist as Mr. Saville Kent.[1] As the fishery inspector of several of the Australian colonies, Mr. Saville Kent has had ample opportunities to make himself acquainted with the marine fauna of that continent; and during three years' investigation for the Queensland Government of the fisheries on the reefs, he has had exceptional facilities for the study of its fauna and the mode of its formation. Mr. Saville Kent is well-known to zoologists as an authority on the Protozoa, Sponges, and Cœlenterata, and we may, therefore, hope to learn much upon each of these groups. As the author has, however, been engaged upon official enquiries, we must expect that a large proportion of the volume will be devoted to economic questions, such as the development of the fisheries. These are extremely varied and valuable, including fish, oysters, pearls, mother-of-pearl, trepang, sponges, dugong, and turtle.

The work will be illustrated by 16 coloured quarto plates and 48 plates in photomezzotype. By the courtesy of the publishers we have been allowed to see these, and to reproduce one as an example. The coloured plates have all been copied from paintings from nature by the author, so that their accuracy may be relied on. They illustrate the fauna of the reefs, and those showing the corals in the natural colours of life will be of especial value. Probably, however, the most important of the plates are the reproductions of photographs of the reef grounds, showing not only great areas exposed at low tide, but also submerged parts of the reefs. Among these, we may especially remark the plate of Skull Reef, showing a wide expanse of coral grounds, and one of Jelly Mould Reef, showing a great diversity of coral genera, including the branching *Madrepora*, the globular masses of *Porites*, and the large clumps of various Astreans. Another plate shows a fine series of typical genera, among which we recognise *Mussa*, *Agaricia*, *Fungia*, *Galaxea*, and *Madrepora*.

One of the most interesting plates to geologists is that giving a view of an inshore reef when living, and one when eroded. The destruction of the specimens of *Madrepora*, *Porites*, and *Millepora*, and the persistence of the rounded banks and clumps of the Astreans is very striking.

Photographs of living coral reefs have been made before; one taken by the Hon. R. Abercromby, at Feejee, is well-known through the enlarged copy in the coral gallery in the British (Natural History) Museum. Mr. Saville Kent's photographs are, however,

[1] The Great Barrier Reef of Australia; its Products and Potentialities. By W. Saville Kent, F.L.S. Announced by Messrs W. H. Allen & Co.

far superior to any we have previously seen, both as works of art, and from the varied nature of the views. They enable us to realise how the scenery of a reef alters with the nature of the genera that formed it. Thus one shows us the shrubby aspect of reefs in which *Madrepora* preponderates, in contrast to the flat, smooth terraces of some species of *Millepora*, or to the hummocky, mound-studded expanses of reefs formed by *Goniastræa*, *Diploria*, and other Pseudothecalia. The photographs must all have been taken before the days of telescopic photography, and the views across wide tracks of level reefs therefore suffer by the distortion of distance. But it is marvellous that, with such difficult subjects, the views are as successful as they are; the genera can usually be recognised, while the general effect is as beautiful as it is instructive. Mr. Saville Kent must be as good a photographer as he is a zoologist, and whatever may be our judgment of the book when it appears, all students of Corals and Coral questions will be grateful to the author for these splendid representations of coral life and growth.

Biological Stations.

It is gratifying to announce remarkable progress of late in the foundation and extension of Biological Stations. We learn from the *Feuille des Jeunes Naturalistes*, of September 1, that Professor Sabatier has now made all arrangements for the erection of the new buildings of the Station established eleven years ago at Cette, on the Mediterranean coast, in connection with the University of Montpellier. The requisite sum of money has been collected, and the erection of the laboratory is now far advanced. The situation is especially favourable for the study of all kinds of marine life, both animal and vegetable, and many important researches have already been carried on in the temporary institution. Another Marine Biological Station has lately been established by private munificence, and by donations from learned societies, at Bergen, on the coast of Norway. This will provide accommodation for ten naturalists, and will be under the direction of Dr. J. Brunchorst. Arrangements are also in progress for the foundation of a small station at Cumbrae, on the west coast of Scotland, with special facilities for the investigation of the marine algæ. In India, too, there is shortly to be a new Biological Laboratory at the Calcutta Zoological Gardens, this with the special object of facilitating researches on snake-poison.

The Anti-Vivisection Challenge.

Apart from the exhibition of beautiful groups of marine life in the Aquaria, the general public manifest but little interest in the ordinary Biological Stations. It is only when a Biological Laboratory is the scene of physiological experiments on the higher animals, that public attention is particularly attracted to it; and this not from any

THE GREAT BARRIER REEF OF AUSTRALIA.

VASE-SHAPED MADREPORA, LOW WOODY ISLAND.

W. Saville Kent, Photo.

"SKULL" REEF, DISTANT VIEW, LOW WOODY ISLAND.

interest in the results of scientific research, but on account of the misplaced sentiment of a certain band of agitators termed the Anti-Vivisectionists. The British newspapers during the last month have devoted much space to the questions raised by these agitators, in reference to a discussion inaugurated by Sir Andrew Clark and Professor Victor Horsley at the recent meeting of the Church Congress. The result, however, is far from edifying, both parties displaying an animosity that is to be regretted in such a discussion; and such heated controversy will doubtless continue so long as the Anti-Vivisectionists rouse the ire of the Physiologists, not merely by their display of ignorance of the subject in dispute, but also by their tissue of mis-statements and misquotations.

It appears that Sir Andrew Clark and Sir James Paget are too busy to enter into a public correspondence as to whether vivisection has ever done any good to anybody. Certain daily papers seem to regard this as a surprising confession of the weakness of the case for vivisection. The writers seem quite unable to realise the medical view of such a request; they might have understood the preposterous nature of the challenge if the President of the Geological Society and the Director-General of the Geological Survey had been asked to show that the use of the hammer had ever furthered geological science, or if the Presidents of the Institute of Journalists and Incorporated Society of Authors had been invited to discuss whether the world owed anything to the use of the pen. How do these journalists imagine the Church Congress would receive an invitation to consider whether even the slightest good had ever been wrought by prayer books? Besides, the discussion of medical details in the columns of the public press would be dangerous; for what with the British Matron and the County Council, the medical contributors to the controversy would certainly get into serious trouble.

Phenology.

Quite apart from the researches conducted in Biological Stations and Laboratories, however, there is much to be done by the ordinary field observer in Natural History, and we note with pleasure another recent effort to systematise some of the researches of local workers. In the *Midland Naturalist* for October, Mr. F. A. Bellamy seeks to enlist the aid of observers in the "science of appearances," or more properly speaking, in the record of the first appearance each year of certain wild flowers, birds, and insects. The object is to study the relations between Natural History and Meteorology, on a plan suggested as long ago as 1875 by the Royal Meteorological Society. This plan, which has been revised from time to time, has been carried on to some extent, but other students are needed who will make observations in accordance with the instructions issued by the Meteorological Society.

The following is a complete list of plants, birds, and insects, of which observations are required:—

Plants.

1.—Hazel (*Corylus avellana*).
2.—Coltsfoot (*Tussilago farfara*).
3.—Wood Anemone (*Anemone nemorosa*).
4.—Blackthorn (*Prunus spinosa*).
5.—Garlic Hedge Mustard (*Sisymbrium alliaria*).
6.—Horse Chestnut (*Æsculus hippocastanum*).
7.—Hawthorn (*Cratægus oxyacantha*).
8.— White Ox-eye (*Chrysanthemum leucanthemum*).
9.—Dog-rose (*Rosa canina*).
10.—Black Knapweed (*Centaurea nigra*).
11.—Harebell (*Campanula rotundifolia*).
12.—Greater Bindweed (*Convolvulus sepium*).
13.—Ivy (*Hedera helix*).

Birds.

1.—Song Thrush (*Turdus musicus*).
2.—Swallow (*Hirundo rustica*).
3.—Cuckoo (*Cuculus canorus*).
4.—Nightingale (*Daulias luscinia*).
5.—Flycatcher (*Muscicapa grisola*).
6.—Swallow (last seen).

Insects.

1.—Honey Bee (*Apis mellifica*).
2.—Wasp (*Vespa vulgaris*).
3.—Small Cabbage White Butterfly (*Pieris rapæ*).
4.—Orange-tip Butterfly (*Anthocharis cardamines*).
5.—Meadow-brown Butterfly (*Epinephile janira*).

Arctic Expeditions.

A preliminary notice of Lieutenant Peary's Expedition to Greenland has lately appeared in the newspapers, and the results prove to be most valuable and satisfactory. The expedition, it will be remembered, left the United States in July of last year, under the auspices of the Philadelphia Academy of Sciences, wintering in the Arctic regions, with the intention of reaching the North of Greenland this summer over the inland ice. The party successfully passed the winter at McCormick Bay as arranged, and on May 15 of the present year Messrs. Peary and Astrup started on their northern journey, reaching the extreme limit of Greenland in latitude 81·37 early in July. The land on the coast was almost free from snow, and the musk-ox was found to be abundant, while foxes, hares, ptarmigan, and other birds, besides insects and flowering plants, were also met with. The sledge journey of about 1,300 miles was accomplished within ninety days. Besides adding so much to our knowledge of the geography of Greenland, the expedition is said to have brought back the richest collection of specimens of the fauna and flora of the Arctic regions hitherto made by any explorers.

The French Expedition to Jan Mayen and Spitzbergen, organised and despatched last June by the French Minister of Public Instruction, under M. Charles Ribot, has also safely returned. The Alpine flora was studied especially on Jan Mayen, and observations were made on the movement of some of the glaciers of Spitzbergen. A very large collection of fossil plants was obtained and brought back to the Paris Museum of Natural History.

More Newspaper Science.

It is curious to remark how slowly scientific discoveries penetrate the minds of those who are supposed to relate them for the benefit of general readers. The author of an article on the Australian marsupial mole (*Notoryctes typhlops*) in the *Saturday Review* of October 15 refers to the animal as if it were still only vaguely known, observes that there is still no information as to its size, and concludes by expressing the hope that before long we may have "better accounts, and possibly a specimen or two, of this singular animal." Considering that *Notoryctes* was the principal form of life discussed at least at two meetings of the Zoological Society of London last Session, while detailed reports on the anatomy and affinities of the animal have already appeared, the *Review* is somewhat out of date. We may also observe that Professor Stirling has deposited specimens of *Notoryctes* in the British Museum, the Museum of the Royal College of Surgeons of England, and the Museum of Comparative Anatomy at Cambridge, where they are accessible to all naturalists. Typical specimens in the British Museum have also been exhibited for some time in the public galleries.

Ethnologists may expect some valuable and interesting observations in Dr. Flinders Petrie's forthcoming work on Medum, the oldest dated site in Egypt. Dr. Petrie has been excavating round the Pyramid of Medum (Haram-el-Kaddab), the tomb of Senefru, the first king of the fourth dynasty, and has unearthed the temple of the pyramid, still roofed and perfect. We learn from the *Daily Chronicle* that, as regards the inscriptions, the most interesting are undoubtedly some *graffiti* on the walls, one of which certainly goes back to the sixth dynasty (B.C. 3300—3100), and which reads, "Thrice beautiful is the name of King Senefru." The first painted texts are of the period of Thothmes III. (B.C. 1600), and it is conjectured that shortly after B.C. 1500 the temple became buried in the sands, thus escaping the destructive hands of later builders.

The Rev. B. J. Harker (Gilnow Park, Bolton) and Mr. Thomas Harker (Grassington, Yorkshire) appeal for contributions to a fund now being collected for the exploration of the tumuli and ancient earthworks at Grassington. Preliminary excavations have yielded numerous human remains, urns, ornaments, and implements, in part referred by Professor Boyd Dawkins to the Bronze Age; and it is expected that more systematic work will lead to results of great value.

The "Queen's Ostrich," about which we have read so much in the papers, has arrived at the Zoological Gardens in London. It is

a particularly fine male bird, and shows a character which we have never before seen in an ostrich at the Gardens. It has a bright red neck—possibly a sexual adornment. The Ostrich tribe generally (the Emeus and Cassowaries, at any rate) show bright colours in this region only, which is, after all, on account of its great extent, a very favourable situation for the development of sexual colours. Unfortunately, the Ostrich has within the last few days been in a less robust state of health than when it arrived; the black boy who accompanied it from Sierra Leone has been summoned in consultation, and has given his opinion that the Giraffe house, which, in the want of any proper inmates, has been given over to the Ostriches, is too hot even for an Ostrich. We believe that this has been remedied. Her Majesty the Queen has most generously presented the bird to the Zoological Society.

Visitors to the Zoological Gardens should also notice some of the new birds and other animals brought by Mr. Frank Finn from Zanzibar and Mombasa, and presented to the Society. This collection includes at least three species which have never been exhibited before in the Gardens. The most interesting of these is, perhaps, a small Water Hen (*Limnocorax*), of which there are two individuals located in the western aviary. As the object of Mr. Finn's visit to Africa was to collect Oligochæte worms for Mr. Beddard, he is to be congratulated on having been able, without neglecting his proper work, to enrich the Society's Menagerie by so large a number of interesting living animals.

The question of the extinction of the American prehistoric horse is re-opened by Dr. E. L. Trouessart in *Science* for September 30. Among other evidence, Dr. Trouessart discusses the recent discoveries of Tertiary horses in South America, and he concludes that the stories as to the absence of the horse in the New World prior to the landing of the Spaniards and Portuguese are quite correct. The extinction of the horse in America "appears to have coincided with that of the Proboscidians (elephant and mastodon) and can consequently be attributed to the same causes, which are to be sought in the environment of these Herbivora (nourishment, nature of the soil, &c.)."

Professor Victor Hensen, of Kiel, is editing the results of the investigation of the pelagic fauna ("plankton") of the Atlantic Ocean conducted by the expedition under his charge in the year 1889. The work is announced by Messrs. Lipsius and Tischer, of Kiel and Leipzig, and will comprise five large quarto volumes, illustrated by more than 300 plates. Each group of organisms is being treated by a specialist.

In the last part of the *Ann. Sci. Nat. Zool.* (vol. xiii., Nos. 4, 5, 1892), Messrs. Milne Edwards and E. L. Bouvier complete their description of the *Pagurus*-like crustaceans of the deep sea. It is well-known that the submerged mountain-chain extending north and south in the Atlantic—the chain of which the Azores, St. Paul, and Ascension are isolated peaks—forms a division between two distinct faunas on the bed of the ocean; and the difference between the Paguridæ of the two sides proves to be very marked.

Mr. Clement Reid favours us with an interesting note on the "Cheese Snail." This species, *Helix obvoluta*, is often spoken of as a doubtful native of Britain, and in most books it is said to be confined to a small portion of the chalk escarpment on the borders of Hampshire and Sussex. The species is, however, abundant in all suitable localities in Sussex, as far east as the river Arun, and its rarity is due to the rarity of suitable stations. *Helix obvoluta* is extremely particular as to its habitat, needing shade, with a dry calcareous soil and a steep slope. It appears, also, to have exceptionally small facilities for dispersal, for it is almost entirely confined to the few remaining patches of woodland and copse which have never been under cultivation, and is absent from the extensive beech woods planted a century ago. As the occurrence of this typical woodland species seems intimately connected with the survival of patches of the ancient forest, it should be carefully searched for in other counties where suitable conditions occur. In all probability, *Helix obvoluta* is less local than is imagined.

The year 1892 has been a noteworthy one for Lepidopterists, on account of the abundance of the Clouded Yellow Butterfly, *Colias edusa*, in Great Britain. Records of its occurrence in many counties have been published in the entomological journals. This species and its congener, *C. hyale*, are well known to be numerous in Britain at irregular intervals, and the cause of their sudden appearance and disappearance has long been a puzzle. In his work on the British Lepidoptera, now appearing, Mr. C. G. Barrett inclines to the view that pressure of numbers on the continent causes a migration to our shores, and that many of the migrants establish themselves and breed here. The present is said to be the best "edusa year" since 1877.

The discovery of the host of the rare Stylopid insect *Elenchus tenuicornis* is announced in the *Entom. Monthly Mag.* (2), vol. iii., p. 249, by Mr. E. Saunders, who captured near Surbiton a nymph of a small Homopteron (*Liburnia*, sp.) from the ventral region of whose abdomen a male *Elenchus* was in the act of emerging. It has hitherto been believed that *Elenchus*, like most other Stylopidæ, was parasitic on bees, and species of *Bombus* have been thought to be its hosts.

The only other Stylopid known to be parasitic on a homopteron is *Colacina insidiator*, whose host is a Bornean lantern-fly, *Epora subtilis*. In the same number of the journal the Rev. A. E. Eaton gives a new description of *Elenchus*, with figures, from Mr. Saunders' specimen, and from a male taken free by himself. The female is still unknown.

Dr. A. Irving has printed in full, for private distribution, a paper on the Bagshot Beds of Bagshot Heath, read last June before the Geological Society of London, and published in an abridged form in the "Quarterly Journal" of that Society. The paper is a controversial one, and deals with a number of minor points connected with the stratigraphy of the Bagshot area, with special reference to a paper by Mr. H. W. Monckton. Geological combats may be interesting and profitable, but the records of them are hardly suitable for publication in the journal of a learned Society, at any rate in the form of a professedly scientific paper: it is quite sufficient if the fighting is done during the discussion, of which brief notes are printed. In connection with this subject we may recall attention to some remarks made by Professor Judd in his Address to the Geological Society in 1888. He then lamented "that the tendency towards bringing immature and controversial papers before the Society is on the increase"; and he was quite right in urging that authors should bring forward "the result of carefully matured effort," rather than "preliminary notes" to be followed by a series of papers that would, from want of concentration and completeness, necessarily burden the literature.

Dr. Charles Barrois (*Annales de la Société Géologique du Nord*, vol. xx., p. 75) has just published a memoir on the Graptolites of France. His conclusions agree with those of Professor Lapworth and others in Britain on the succession of zones marked by different forms of Graptolites in both Ordovician and Silurian strata. In France, as in this country, the species are preserved most abundantly in carbonaceous shales or slates; but they occur also in calcareous and arenaceous rocks, so that they were widely dispersed irrespective of sedimentary conditions. Their importance, therefore, in correlating formations in distant areas is apparent. Several forms of Graptolites that have been obtained in Britain are at present unknown in France, and those that have been found in the Corbières, the Pyrenees, Ardennes, and Brittany are, as a rule, poorly preserved and difficult of identification. In Languedoc and Normandy, better specimens have been obtained. Dr. Barrois' memoir is most valuable in summarising the present state of knowledge.

Most of the geological formations of Europe are known to have their equivalents in the New World, but it is remarkable that, until quite recently, the Americans have been unable to recognise in their country any representative of our familiar Lias The discovery,

however, has at last been made, and Messrs. J. S. Diller and A. Hyatt (*Bull. Geol. Soc. America*, 1892, pp. 369–412) announce the occurrence of the formation near the summit of the Sierra Nevada, in Plumas Co., California.

In a paper on the Trias of Cannock Chase (read before the Liverpool Geological Society, 1892), Mr. T. Mellard Reade refers to certain "indented pebbles" the depressions in which have usually been attributed to the effects of pressure. He is of opinion that the surfaces of siliceous pebbles at the point of contact in the Triassic rock have been eroded by the solvent power of water.

In reference to M. Carnot's observations on fluoride of lime in fossil bones noticed last month (p. 565), Mr. T. L. Phipson contributes to the *Comptes Rendus* (vol. cxv., p. 474) an observation of some interest. He remarks that many years ago he analysed a piece of fossil wood from Cretaceous sandstone (evidently Wealden) in the Isle of Wight, and found so large a percentage of phosphoric and fluoric acids, that mineralisation appeared to be almost entirely effected by phosphate of lime with a small admixture of the fluoride.

The most detailed account of the Dover Boring hitherto published in any journal has just appeared in the *Annales des Mines* (1892, pp. 227–232). The particulars are given on the authority of Mr. Brady, the Engineer, and they are communicated by M. E. Lorieux.

In the October number of the *Scottish Geographical Magazine* the Prince of Monaco publishes a new chart of the currents of the North Atlantic, presented to the British Association at the Edinburgh meeting this year. Nearly 1,000 floats were used by the Prince in the course of his researches, and of these 227 were returned with particulars of their discovery on various coast-lines. A curious great vortex is recognised in the ocean to the west of the Azores. "Just as in an atmospheric cyclone, there exists in this oceanic vortex a region of calm, where the waters do not follow any regular direction, and when the floats enter this region they remain there often for months or years."

The Times publishes news of Mr. W. M. Conway's Expedition to Mount Godwin Austen and its vicinity in the Hindu Kush, already referred to in Natural Science (March, p. 6). The exploration of the glaciers is being prosecuted with success, and Mr. Conway has reached an elevation of 25,000 feet.

Another expedition has just left England for Eastern Africa under Lieutenants C. H. Villiers and Bennett Stanford of the Horse

Guards. The party intends to proceed by an unknown route from Kismahu to Lake Rudolf, and will probably return across Somaliland. Mr. J. W. Gregory, of the British Museum, accompanies the expedition as naturalist and geologist, by permission of the Trustees of the British Museum, and it is hoped thus to obtain important acquisitions for the National collection.

Mr. William Wilson sends a note from Alford, Aberdeen, N.B., on the phenomenal duration of the flowers of the Broom (*Cytisus scoparius*), which he has observed this season. He says it has been generally a late season for the flowering of plants, and it is usual in such years to find a very meagre flourish upon the Broom. This season, however, the flourish has been exceptionally large. What has still more surprised those acquainted with the habits of the shrub is the very long time during which it has remained in flower. This cannot be due to the cold weather, as in former cold years the bloom has suffered. Mr. Wilson, who claims to have studied the shrub for several years, believes that the bacterioids associated with the roots are the cause of several peculiarities of the plant, and thinks the above peculiarities in the flowering are in some way due to the reaction of the nature of the season on those organisms.

Baron Ferdinand von Mueller contributes a note to the October number of the *Journal of Botany* on the sudden death of Mr. Robert Fitzgerald, F.L.S., which took place on August 13, at his residence, Hunter's Hill, Sydney, in his sixty-second year. The Baron says, "his orchidographic researches, supported by a rare ability in plant-drawing, are beyond all praise. The greater number of Australian orchids are done by him for his superb work, but it is to be lamented that he did not live to complete it." In 1869 he visited Lord Howe's Island with Mr. Charles Moore, "when for the first time the almost entirely endemic vegetable treasures of that isolated spot between New Zealand and Norfolk Island became revealed." He there ascended the "dangerously steep Mount Lidgbird" discovering the 40 ft. high *Dracophyllum fitzgeraldi*. "His observations on the fertilisation and hybridisation of numerous Australian species are highly important." His researches were mainly in New South Wales, though he made a lengthened tour to West Australia to study in the living state its largely unique Orchid flora.

The Narcissus seems to be ousting the Potato in the Scilly Islands, according to the *Gardener's Chronicle* for September 3. The Narcissus crop now takes the precedence of the tuber; many who grew potatoes largely a few years ago now growing none at all. Fields of hundreds of thousands of beautiful Narcissi may often be seen in bloom in February and March. We are told that one grower will have under cultivation this season no less than 20 acres.

In the *Gardener's Chronicle* for September 3rd is a description of a new fruit, raised by Mr. Culverwell, a hybrid between the gooseberry (*Ribes grossularia*) and the black currant (*Ribes nigrum*). As both the plants belong to the same genus, the production of a fruit-bearing hybrid is not a surprise. One who has seen the bush says it "looks like a gooseberry bush with currant-like leaves, and the fruits are like small gooseberries in bunches of two, three, or four on one stalk." The fruits were seedless, of the size of black currants, but coloured like a red gooseberry and beset with fine hairs. The spines so noticeable in the gooseberry were absent. The flavour "partook of that of the gooseberry mixed with that of the black currant, an improvement on both as it seemed to us."

Lieutenant Stuart Wortley, who has been experimenting at the Agricultural College at Downton on the poisonous principle of the Yew, has arrived at a somewhat curious result, which he has communicated to the *Times*, with an account of his experiments. His object was to test a theory which declared the female Yew to be harmless to cattle, the male plant only being poisonous; and the Lieutenant, having chemically analysed the plants, declares that *taxin*, the presumed poisonous principle, is contained chiefly or entirely in the male plant. We may accordingly grow the female in our parks and pastures with no fear of the results to our cattle, but, as the *Gardener's Chronicle* aptly observes, "how are we to know before flowering which is the male and which the female?" Sometimes, too, the female Yew produces also male flowers; will it then also develop taxin and become poisonous? M. Ch. Cornevin, in his *Plantes Vénéneuses*, published in 1887, mentions no difference between the sexes, but says that the young leaves are comparatively harmless, while as they grow older and deeper in colour they become more and more poisonous.

In *Zoe* for last July, Mr. Wm. W. Price tells of his discovery of a locality for the gigantic red-wood trees (*Sequoia gigantea*) further north than any hitherto known. In Placer County, fifteen miles east of Forest Hill, on one of the streams flowing into the middle fork of the American River, at an altitude of about 5,000 feet, he found a small grove of six trees occupying about an acre of ground. Though unrecorded by naturalists, it is not unknown to prospectors, as many dates were found cut in the bark of neighbouring alder trees. The two largest sequoias are about 12 ft. in diameter, but a fallen trunk measured 20 ft. across. The position is a very sheltered one, shut in by the sides of a small, thickly wooded cañon, a fact which may account for the presence of these stragglers so far north. So secluded is the spot, that the trees cannot be seen till within a hundred yards, and Mr. Price was only enabled to find it by the help of a miner from

the almost deserted camp of "Last Chance," about eight miles from the Grove.

Messrs. Cassell & Co. on October 12 issued the first number of a new weekly periodical entitled *Cottage Gardening*. The journal, which will also deal with poultry, bees, allotments, simple cookery and housekeeping, is edited by Mr. W. Robinson, author of "The English Flower Garden." The price is one halfpenny. The present issue consists of eight pages, all readable matter, there being no advertisements. The front page is occupied by a short eulogy on the English cottage, illustrated by an engraving from a picture by Alfred Parsons. The original is evidently a very charming little picture, but the reproduction is, unfortunately, somewhat of a smear. There are four other illustrations, the best representing a potato known as the white elephant, the others rather poor, that on the back page, of the cottager's pig, a "sow of the large white breed," supported by a gate and a bank of earth, being very black and white. The letter-press contains several pages of useful hints, such as advice on planting bulbs, rose cuttings, the best crysanthemums for October bloom, the extermination of the gooseberry caterpillar, window boxes in winter, the raising of early tulips for room decoration. Instructions are given for the laying-out, trenching, and manuring of allotments, and there are also some notes on poultry keeping, bees in cottage gardens, and the pig. A page is devoted to domestic affairs, and there is, of course, the inevitable prize competition. Answers to correspondents will be a feature, and the journal will doubtless prove a boon to the class for which it is intended.

We have recently been favoured with a glimpse of parts vi. and vii. (Spongozoa and Rhizopoda) of the "Museum Normanianum; or A Catalogue of the Invertebrata of Europe, and the Arctic and North Atlantic Oceans, which are contained in the collection of the Rev. Canon A. M. Norman, M.A., D.C.L., F.R.S., F.L.S., &c. Printed for Private Distribution. Durham [printed], 1892." Canon Norman's idea of printing a catalogue is excellent, for so many type-specimens are contained in his collection, and we hope other large collectors will follow his example. But why not issue the Catalogue for sale? The fact of its being *privately* distributed renders it of little value, since those most in want of it often remain quite ignorant of its existence. We notice, moreover, that Canon Norman has proposed for certain species some new names, which we forbear to quote; they cannot possibly be considered as published, and if they become entered in lists will be productive of much inconvenience. It is bad enough to propose names in indexes, footnotes, or other obscure places, but when this is done in privately-printed pamphlets, the nuisance is intolerable.

I.

The Evolution of Consciousness.

I PROPOSE to set before the readers of NATURAL SCIENCE, in as brief and simple a form as possible, an hypothesis concerning the evolution of consciousness which appears to me to be the legitimate outcome of enquiries which are strictly scientific. I use the word consciousness in its broadest and most comprehensive sense, as embracing all that belongs to feeling, sentience, or the psychical aspect of existence.

Let us take our stand at starting on the firm foundation of common observation. I hold in my hand an object, not unfamiliar to some naturalists, a briar-wood pipe. I touch it, see it, taste it, smell it, and hear its pleasant gurgle as I draw the smoke into my mouth. If anything in the world is real to me, that pipe is real. I shall take it as my standard of real existence. Now in what does this real existence consist? I may state the answer to this question in two forms, both of which are different expressions of the same fact:— (1) An object in consciousness exists. (2) There is a consciousness of the object. These are obviously only different ways of putting the same fundamental fact of experience. But in the first, prominence is given to the objective side of the fact, while in the second prominence is given to its conscious or subjective side. Physical science takes up the objective side for special study and investigation. It explains the object-in-consciousness which is for direct observation a pipe in terms of other objects-in-consciousness, molecular vibrations, modes of energy, and so forth. It thus reaches what Dr. Johnstone Stoney calls the diacrinominal hypothesis, that all objective phenomena are constituted by motions or groups of motions; or some other such physical explanation of the objective world. *But* it never shakes itself free of consciousness. It explains this object-in-consciousness in terms of other objects-in-consciousness. It can do no more.

Let us here digress for a moment, that we may clearly grasp what is meant by the words "object" and "objective." They are used in two closely-connected and yet somewhat different senses. In what may be called the narrower sense, the word "objective" applies to all that belongs to the primitive perceptual object-in-consciousness as contrasted with that which belongs to the consciousness-of-the-object. Thus all that we know, or can know, concerning my pipe, as regarded by physical science, is objective knowledge, as contrasted with all that we know, or can know, concerning my impression or idea

of the pipe as a mental product: the latter belonging to the subjective sphere. In the more extended sense an object is that which is in the focus of the mind's eye. My pipe is an object of perception, in the focus of the organic visual sense. Molecular vibrations are objects of conception in the focus of the eye of thought. Both are objects-in-consciousness, and both are equally real. Physical science, then, takes up the objective side (in the narrower sense) of the fundamental fact of experience, and endeavours to explain it in terms of other objects-in-consciousness, such as modes of energy.

Psychology, on the other hand, takes up the subjective side of the basal fact of experience, namely, the consciousness-of-the-object. It explains the existence of the pipe in terms of perceptions, impressions and ideas, sensations, and so forth. It may thus reach the conclusion that my pipe is what I have elsewhere termed a "construct," and that the mind has, at the bidding of an external stimulus, the power of building up the results of previous experience into that particular object-in-consciousness. *But* it can never shake consciousness free of the object-in-consciousness. Inseparably given in the simplest observation of daily life, they remain inseparably united throughout the whole range of knowable existence.

This may be enforced by an analogy which is somewhat more than an analogy. Let consciousness be represented by the visual sense, and the object-in-consciousness by the light waves which stimulate it. For clear vision, there are required not only a highly-developed organ of vision, but also a well-illuminated object in the focus of vision; and for any vision at all, however elementary vague or dull, *both* factors must co-operate. There must be some sort of visual sense, however rudimentary, and some sort of light stimulation, however indefinite. So, too, for consciousness there must be some form of sentience, however rudimentary, and some sort of object, however indefinite. Consciousness without an object is a metaphysical abstraction. And psychology, when it takes up the subject-side of the fundamental fact of experience, and endeavours to explain it in terms of those objects-in-consciousness which we call perceptions, sensations, and the like, does not attempt to tell us anything about consciousness out of relation to objects.

Now there are certain people called metaphysicians, who try to get beyond the bounds of this inevitable relationship. On the one hand there are some who say that objective matter or energy exists as such independently of consciousness. On the other hand, there are others who say that subjective consciousness or mind-stuff has this independent existence; and the exasperatingly confusing thing is, that these people must needs apply the term *real* in a new sense to these most unreal of all abstractions. Dr. Johnstone Stoney has suggested in place of the word *real* in this unnatural sense the word *autic;* and it would be a great blessing if his suggestion were generally adopted. Autic existences are called noumena as opposed to

phenomena. Noumena are, therefore, existences out of that inevitable relation which is given in fundamental experience; and as I know nothing whatever about noumena or antic existences, I leave them without further ado to those who pretend to such knowledge.

I deal entirely with phenomena, but with phenomena in their double aspect—objective and subjective. Let me represent in tabular form the distinction between the two :—

By Psychology.		By Physical Science.
Explained as the consciousness of an object in terms of those subjective phenomena we term sensations and perceptions, &c.	Pipe	Explained as an object in consciousness in terms of those objective phenomena we term matter and energy, &c.

I have before contended in these pages that it is part of the very grammar of science to keep these two aspects distinct, and I see no cause to abandon this position.

Let it be clearly understood, then, that in suggesting an hypothesis with regard to the evolution of consciousness, I am dealing with the conscious aspect of phenomena as given in practical experience, and am not attempting to get behind phenomena, or to shake myself free of a relationship which I hold to be inevitable.

Now the pity of it is that I cannot, as the world is now constituted, get directly at the conscious aspect of phenomena in any other being or thing than myself. It is a dreadful drawback; but there is no use whining about it; one must make the best of what one *can* do; and what I, *qua* man, can do is this. I can study with all possible patience and care the association of conscious and physical phenomena in beings which, though not me, are, at any rate, uncommonly like me, and which, though they cannot directly show me their consciousness, can, at least, in various ways assure me that they are conscious. I do not pretend that the results of this study are of assured and incontrovertible validity; but I do think that we have some grounds for assuming as a working hypothesis that consciousness is associated in me and my like with certain complex modes of energy in my brain or some part of me. If this be so we get the possibility of a correlation which may be thus expressed in tabular form :—

Psychical Aspect.		Physical Aspect.
Presenting to Subjective Study certain phenomena we term States of Consciousness.	Man.	Presenting to Objective Study certain phenomena we term Neural Modes of Energy.

Or, by means of a very rough diagram, it may be put thus :—

YOU. ME. THE WORLD.

The small circles represent you and me, or that part of us which is concerned in sentience and thought. The white half of me repre-

sents my consciousness in relation, directly or indirectly, with the great world of objective phenomena. But if you could get at my brain—my black or objective side—you would find that while I was experiencing sentience and thought, you were observing modes of nervous energy; and if we then compared notes we should find that the consciousness and the neural energy varied, not independently, but in strict correlation. This may be due either (1) to an invariable association of states of consciousness with neural tremors (dualism); or (2) to the fact that neural tremors and states of consciousness are, so to speak, the different ways in which the same occurrences present themselves to you and to me at the supposed moment of observation (monism). For my present purpose it matters not which view is adopted.

Let us first consider the modes of energy—my black side. I assume that they have been evolved. But evolved from what? They certainly were not present as such in the fertilised egg-cell from which I have been developed. From what then have they been evolved? The answer given by evolutionists is: From the simpler modes of energy of that fertilised egg-cell. And from what has this, in common with all that is organic, been evolved? Well this takes us a long way back, and the answer is little more than either a guess or a pious (perhaps some would say impious) belief; but from the standpoint of thorough-paced evolution organic modes of energy have been evolved, somehow and somewhere, from inorganic modes of energy. That is the only suggestion natural science, as such, has to make in the matter. From the objective aspect of the evolutionary process, therefore, neural modes of energy have been evolved from *infra-neural* modes of energy of decreasing order of complexity till we reach the simpler modes of energy of inorganic nature.

Now let us turn to the states of consciousness—my white side. I assume that they too have been evolved. But evolved from what? They presumably were not present as such in the fertilised egg-cell from which I have been developed. Well, then, from what have they been evolved? I do not pretend to do more than make a guess, but I try to guess on scientific lines. I suggest that, just as the neural modes of energy have been evolved from infra-neural modes of energy, so have states of consciousness been evolved from *infra-conscious* states; and just as the infra-neural modes of energy stretch back (on the evolution hypothesis) through decreasing orders of complexity till we reach the simple modes of energy of inorganic nature, so, I suggest, do the infra-conscious states, which are associated with the infra-neural modes of energy, stretch back through decreasing orders of complexity till we reach the simple infra-consciousness of inorganic nature; and further, in reference to the rough diagram of p. 661, I suggest that just as the nervous energy of you and me, which has been evolved from the black or objective side of the world, are associated with states of consciousness or a white side, so, too, does

the whole black world of infra-neural energy have its white or infra-conscious aspect, *if we could only get at it.* The worst of it is that we cannot do so.

Voilà tout! That is the suggestion; speculative if you will, but not as it seems to me unscientific.

A few words in conclusion to present the matter from a somewhat different point of view. Consciousness exists: of that there is no doubt. How did it come to exist? There seem three possible answers to this question. (1) It was directly created in man, or in some lower organism from which man has been evolved. (2) It has been directly evolved from energy. (3) It has been evolved, as I have suggested, from infra-consciousness.

Now the first answer, that of special creation, is, in my opinion, a logically tenable one, and one with which I have sincere sympathy. I do not hold it myself, because it does not seem to me either the highest or the most probable view of the matter; but if others hold it on these grounds, so let it be; and these remarks apply in due degree to the mode of origin of organic nature, and of man. With the second answer, I am in distinct and direct antagonism. I do not think it has a single genuine fact of observation or a single rational inference from observation in its favour. Its supporters may be left to make out a case for it if they can. The third answer is that which I hold and advocate. If, then, these three answers exhaust the logical possibilities of the case, and if the second is inadmissible through default of evidence in its favour, we are left in presence of the first and third. Either special creation or evolution from infra-consciousness, there is no other alternative. *Uterum horum mavis accipe.*

C. Lloyd Morgan.

II.

Primæval Man: A Palæolithic Floor near Dunstable.

ALL persons interested in the subject of the antiquity of man have read Professor Prestwich's recently-published papers in the *Quarterly Journal of the Geological Society* and the *Journal of the Anthropological Institute*[1] on the stone implements found on the chalk plateau of Kent in the Darent district. Palæolithic implements of a similar class have for several years past been found by me in the drift which caps the highest chalk hills of south Bedfordshire and north Hertford-

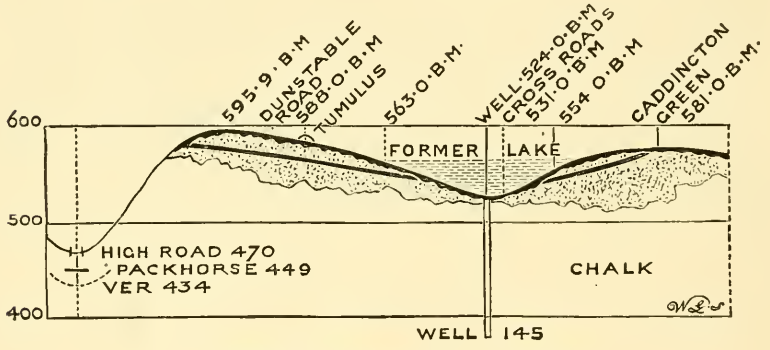


FIG. 1.—Section through Caddington Hill, Dunstable.

shire, and a brief preliminary note from my pen on these discoveries will be found in *Nature*, vol. xl., June 13, 1889, p. 151.

I must say here that the implements I am about to mention are *bonâ fide* implements and works of art. The dubious and disputed forms which have been described as implements of human make from the chalk plateau of Kent occur here also in large numbers, but it is impossible for me to accept them as of undoubted human origin. Excellently made and symmetrical implements occur on the Kentish chalk plateau, and similar implements occur on the hills here, and to such well-made instruments of undoubted human design I alone refer.

The accompanying section (Fig. 1) is taken through one of the hill-tops near Caddington, about two miles to the south-east of Dun-

[1] Noticed in NATURAL SCIENCE, April, 1892, p. 85.

stable, east of the high road, and looking north; the horizontal scale is two-and-a-half inches to one mile, the vertical scale half-an-inch to one hundred feet. The figures show the hills (by no means the highest of the district) to be from 581 ft. to 595 ft. above the Ordnance datum, and from 130 ft. to 146 ft. above the nearest dry chalk valley. The Ver rises as a mere drain a mile or more to the south. "B.M." on the Section means "Bench-mark."

The upper thick black line represents highly tenacious red brown drift clay, which was at one time probably continuous as a flattish stratum over where the dry chalk valleys now exist, and before the valleys were lowered by denudation to their present depth. A similar stratum caps all the hill-tops in the neighbourhood. In this red brown clay, slightly abraded, ochreous, well-made Palæolithic implements and flakes are frequent. Both types of tool occur, pointed and ovate.

Beneath this stiff clay, Tertiary clay, shown by the dotted tint, occurs. This clay rests directly on the chalk rock, shown by the lower thin undulating line.

The Tertiary clay is shown in the illustration as divided by a thick black line, this line representing a Palæolithic land surface, living place, or floor, on Tertiary clay. The clay beneath the black dividing line has never been disturbed, but the clay above the floor line has in very remote times been relaid.

The section proves that the extensive depression still existing on the hill-top was once a lake on the practically impervious Tertiary clay, and that the men who lived on the old clay surface were not true riverside men, but veritable Palæolithic lake-side dwellers.

The stone tools found by me on this ancient living-place were obviously made before the upper mass of water-laid Tertiary clay was deposited, as well as before the time of the deposition of the implementiferous, contorted, deep-brown drift above. The brown drift is, moreover, capped by another ancient drift with abundant black Lower Tertiary pebbles.

The Palæolithic implements found on the floor, unlike those from the drift, are never ochreous, as the Tertiary clay both above and below this floor is not an ochreous matrix. The floor is in some places more than twelve feet below the ochreous implementiferous drift above. Whatever age, then, the Tertiary clay tools may be, they must be older than the movements—whatever those movements were—which first tore up and then relaid with water enormous quantities of Tertiary clay, next deeply ploughed the upper tenacious contorted drift into that clay, and, lastly, deposited a second drift on what are now the highest hill-tops near Dunstable.

A detailed section to a larger scale is shown in Fig. 2. A represents the upper drift with Tertiary pebbles, capped with humus and abundant jet-black lustrous Neolithic implements and flakes. B is tenacious brown drift clay with ochreous Palæolithic implements.

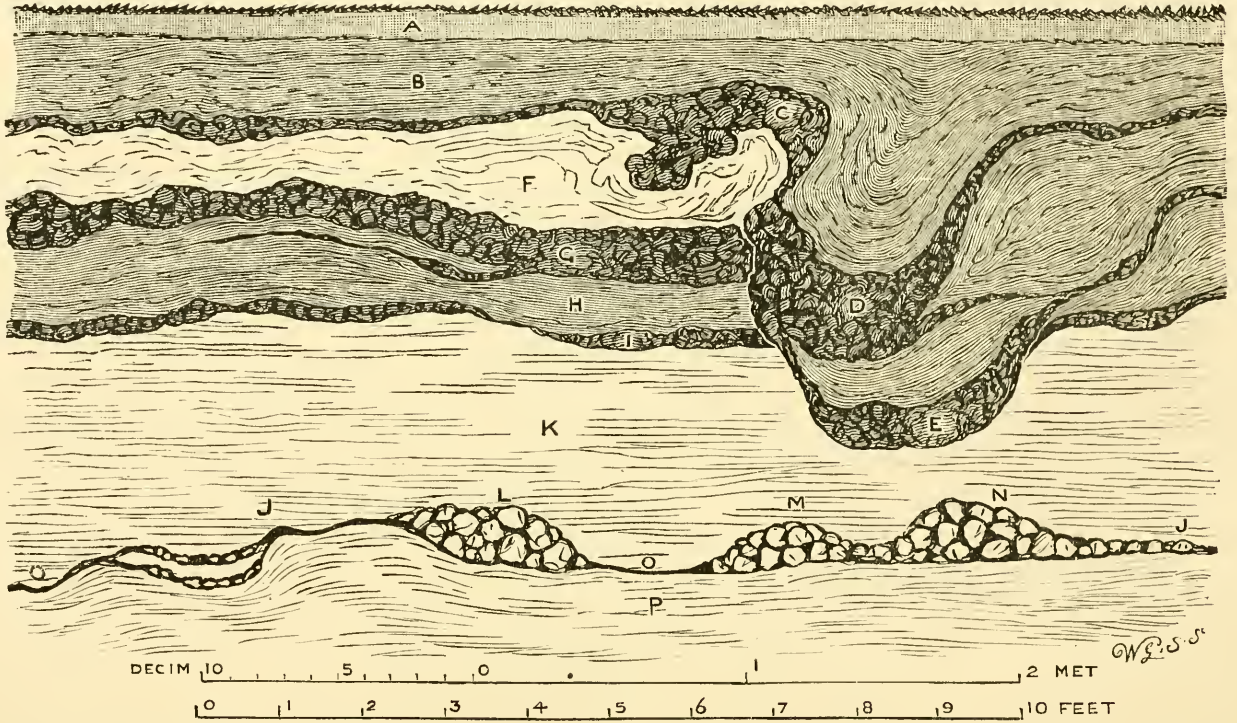


Fig. 2.—Section at Caddington of Palæolithic floor on Tertiary clay, surmounted by relaid Tertiary clay and contorted, implementiferous red drift.

C, D, and E is ochreous gravel containing similar implements; F, whitish clay with whitish Palæolithic implements; G, gravel with lustrous-whitish Palæolithic implements and flakes; some of these flakes have been replaced by me on to the cores from which they were originally struck; I, same as G; J, J, Palæolithic floor on Tertiary clay; K, relaid Tertiary clay covering up the Palæolithic floor; L, M, N, heaps of flints brought by hand in Palæolithic times from the red clay-with-flints, or chalk-with-flints, and placed upon the floor by the margin of the old lake for the purpose of flaking into implements; O, O, Palæolithic floor with sharp-edged implements and flakes; P, Tertiary clay *in situ*. Small pieces of chalk sometimes occur in the cavities of the larger flints, and similar pieces rarely occur upon the floor.

The whole Palæolithic living place on Caddington hill was in very remote times so gently covered with water holding Tertiary clay in suspension that all the objects left on the floor in Palæolithic times may be found in position now, in fact, exactly as they were left by our precursors of old. Flakes of all sizes occur in hundreds, nearly all as keen-edged as knives. The actual places where the men and women sat and worked may be fixed without doubt, as the flakes at certain spots can be replaced on the blocks from which they were originally struck, and even on the finished implements themselves. I have conjoined more than five hundred of these flakes, fitting some on tools and others on cores or other flakes; but few flints of my perhaps unique group-find resemble in colour the lustreless indigo-black flints found and replaced by my friend Mr. F. C. J. Spurrell at Crayford—my examples are white, or beautifully marbled and blotted indigo and white, or like tortoise-shell in colour, and generally lustrous.

It was remarkable to find artificially transported and piled up flint blocks taken from the chalk or red clay-with-flints, but, perhaps, still more remarkable to find, as I did, groups of the larger and better flakes obviously carefully selected and placed in small heaps by themselves. The flakes from these little piles had in some instances been struck from the same block, as they were capable of being replaced upon each other.

It goes without saying that, in a position like the one here described, the whole Palæolithic stock-in-trade—slender enough as it was—must be present on this living place.

The replacement of the flakes will be better understood by reference to the accompanying illustrations. Fig. 3 shows an edge and side view, one-half the actual size, of a finished implement, found at Caddington, and broken in two (probably by use) in Palæolithic times. The two pieces were found on the floor by me about three feet apart, and the two pieces are in a slightly different mineral condition. Fig. 4 is the reverse side of this conjoined implement, showing a large flake re-attached to one edge, a smaller flake

towards the other edge, and a small flake at the base. The thick black lines show the junctions. I have also re-attached a flake to the other side of this tool as shown in Fig. 5; Fig. 6 shows a Palæolithic implement, also from Caddington, in an unfinished or initial condition, one-half the actual size; the basal part is finished, but the upper part was never completed. Near this unfinished tool I found nearly every flake which had been struck from the original block from which the tool was made. Fig. 7 shows one side of the same implement with numerous flakes re-attached, and showing the form

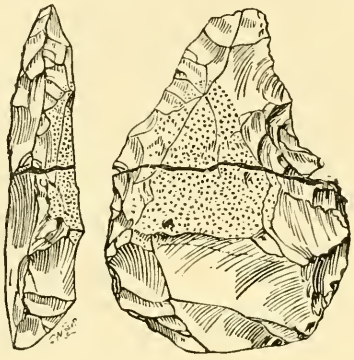


Fig. 3.

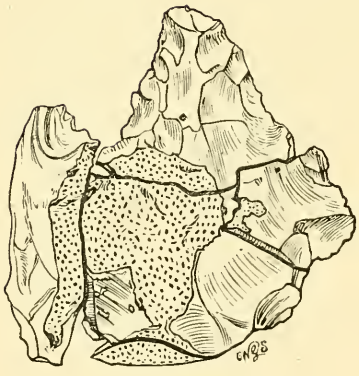


Fig. 4.

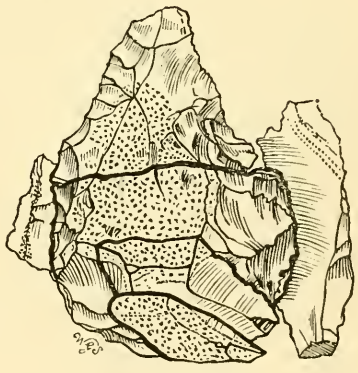


Fig. 5.

FIGS. 3—5.—Flint Implement from Caddington, made and broken in Palæolithic times; one-half nat. size. In Figs. 4, 5, some of the original flakes are shown conjoined.

of the original block of flint selected by the man of primæval times for flaking into an implement.

The facts briefly mentioned only indicate a few of the results obtained. I have had the position to myself for several years, and I have measured, drawn, and photographed various sections, and kept everything together with great care. I received permission from the owners of the pits to excavate on my own account, so that the work

done up to the present time has been under my close supervision. A good deal of the digging has been done by myself.

Fig. 6.—Unfinished Palæolithic Implement from Caddington; one-half nat. size.

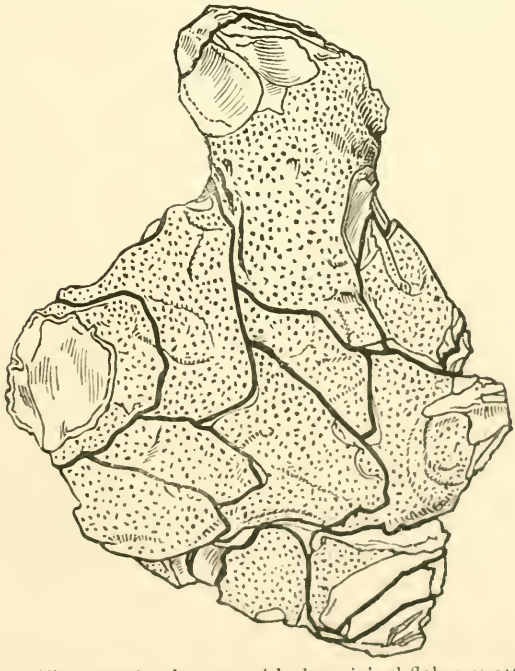


Fig. 7.—The same Implement, with the original flakes re-attached.

No work has been done since last spring, so that the banks of the Caddington pits have since then crumbled in or tumbled down, and

the fallen material is just now thickly overgrown with coltsfoot and other weeds. I hope, however, to be able to resume work soon, and in the meantime I am engraving a map of the district, with a complete set of sections, the chief implements, and the most noteworthy masses, large and small, of conjoined examples. The full account, when published, will throw light on numerous critical points of interest, which will suggest themselves to readers, but which I have not adverted to in this short note.

Worthington G. Smith.

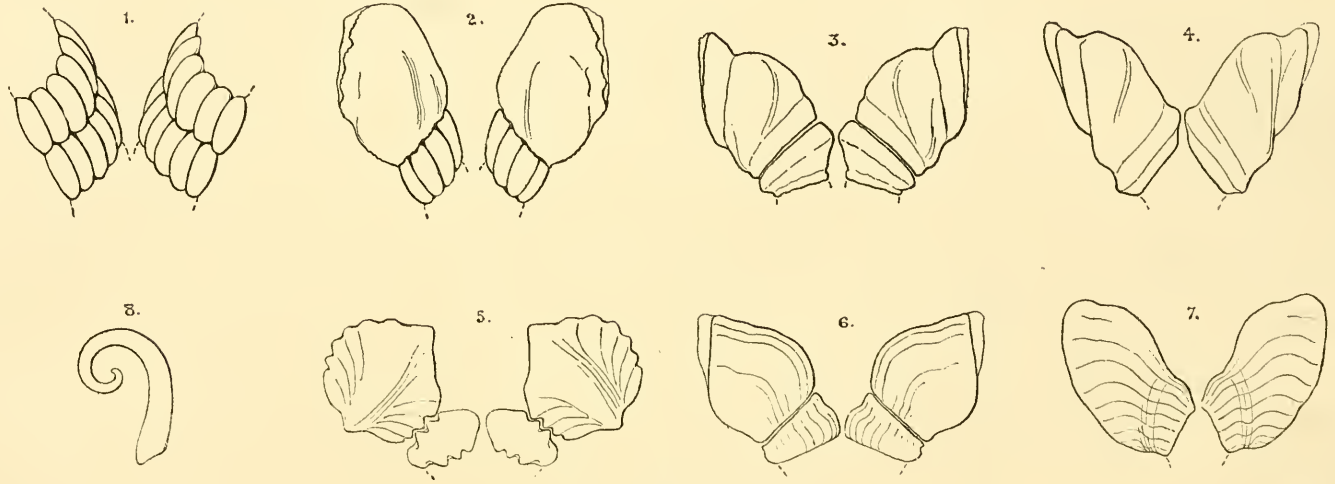
III.

The Evolution of Sharks' Teeth.

SO much has lately been written concerning the development and modes of complication of the teeth in the highest vertebrates, the Mammalia, that it may be of interest to summarise our present knowledge of the phenomena in question, as illustrated by some of the lowest vertebrates, the Elasmobranchs or Sharks and Skates. If the teeth in mammals are frequently complicated and modified by the fusion of adjacent cusps and by their splitting (as now claimed by most competent observers), it is probable that the fundamental laws governing such modifications will produce analogous results under the simplest conditions as exemplified in the dentition of the cartilaginous fishes. In each case the known palæontological history of the various groups of animals is tolerably extensive; and it is thus possible to institute satisfactory comparisons in all essential particulars.

I.—*The Fusion of Adjacent Cusps.*

It is a familiar fact that the calcified tubercles in the skin of numerous Elasmobranchs, both living and extinct, are often fused by their base into little groups, though generally without much constancy or regularity of arrangement. It is thus to be expected that the same complication of the tubercles will occur in the mouth, where their function as teeth may be deemed to specially favour this process. The fusion does indeed take place, and the only peculiar features to be noticed are the constancy, regularity, and symmetrical arrangement of the little groups of cusps or "teeth." In all the most primitive sharks, the inserted base of the cuspidate teeth is a great flattened expansion, exactly like that of each tubercle or group of tubercles in the external skin; and the polished shining cusps are at first always well separated above the base. Such teeth are well-known from Palæozoic rocks under the names of *Diplodus*, *Cladodus*, &c., and it may be remarked that they never consist of more than a single row of points, thus showing that they originate from adjacent cusps developed simultaneously in one and the same series. The relative sizes of the cusps, of course, vary much in the different sharks, as also do their numbers in the respective "teeth"; and in some cases the actual fusion of the cusps well above the base begins to occur, more especially when they assume obtuse proportions.



CRUSHING TEETH OF SHARKS.

Fig. 1. *Cestracion*. Fig. 2. *Psephodus*. Fig. 3. *Cochliodus*. Fig. 4. *Deltoptychius*. Fig. 5. *Pleuroplax*. Fig. 6. *Deltodus*. Fig. 7. *Pœcilodus*. Fig. 8. Section of Cochliodont dental plate, showing in-rolled outer border.

In short, compound cuspidate teeth in sharks are always uniserial, and owe their origin to the constant and regular fusion of primitively separate, adjacent, simple cusps.

II.—*The Fusion of Successional Teeth.*

In accounting for the complication of cuspidate teeth in mammals, however, Prof. W. Kükenthal informs the writer that he is inclined to proceed beyond stating that such teeth result from the fusion of simple adjacent cusps. He even suggests that a successional set of cuspidate teeth may fuse completely with the set of fully-formed teeth already in front—that in such primitive mammals as *Polymastodon*, for instance, each tooth may be a compound of cusps derived from both the first and second sets, which normally develop separately and one after the other.

It is of great interest to note that precisely the same phenomenon can be observed in a certain specialised group of extinct sharks, characteristic of the latter part of the Palæozoic epoch. The family of Cochliodonts, of which little is known except the dentition (1–6, 8), is so named from the great shell-shaped plates into which its principal grinding teeth have more or less completely coalesced; and all circumstances point to the conclusion that these simple plates are the equivalent of several distinct rows of successional teeth in the ordinary sharks with grinding teeth, as represented by the living *Cestracion*.

The Port Jackson Shark, or *Cestracion*, as is well known, exhibits two principal series of grinding teeth on the middle of each half of the jaw (Fig. 1), in which there are five or six successional teeth behind (or within) the foremost row. In *Psephodus* (Fig. 2) the equivalent of the hinder of these two series forms a great simple plate; and this is shown by abnormal specimens (Davis, No. 1., pl. lv., fig. 4) to consist of three rows in succession. In *Pleuroplax* or *Pleurodus* (Fig. 5), *Deltodus* (Fig. 6), and *Cochliodus* (Fig. 3), each of the two series is fused into a continuous plate, which always distinctly exhibits traces of its components in the first two genera. In *Pœcilodus* (Fig. 7) and *Deltoptychius* (Fig. 4), not only do the two plates occur, but they are once more fused together at their adjacent border into one continuous piece. The coalescence of the teeth is so complete in all cases, that their mode of growth is much changed; the once-separate outer tooth can no longer fall away from the mouth, as growth of tooth-substance takes place within, and the external border thus coils inwards like a scroll, as shown in Fig. 8.

Briefly, then, compound crushing dental plates in sharks result not only from the fusion of adjacent teeth, but also often from the coalescence of several successional teeth.

III.—*The Multiplication of Similar Cusps.*

Fusion of cusps and plates, however, will not explain all the

phenomena observed in the process of complication of sharks' teeth. There must be some other means by which cusps can be occasionally added and suppressed. In some modern Lamnidæ, for example, the development of lateral denticles in the teeth is very variable and uncertain ; and the palæontological history of the dentition of the Notidanidæ (7) is especially difficult to comprehend, except on the theory that development sometimes leads to the multiplication of similar parts when they occur in series.

The evolution of the teeth in the Notidanidæ is, indeed, so noteworthy, that the principal stages have been illustrated in succession in the accompanying Figs. 9–12. The earliest known tooth closely approaching that of *Notidanus* in shape is one from the Lower Oolite

TEETH OF NOTIDANIDÆ.

Fig. 9. "*Hybodus polyprion.*" Fig. 10. *Notidanus daviesi.* Fig. 11. *N. microdon.* Fig. 12. *N. gigas.*

(Fig. 9): it is commonly referred to *Hybodus polyprion*, and only differs from the tooth of the ordinary *Hybodus* in the remarkable reduction of the cusps at one end. The next form of tooth, in the Upper Oolite, referred to *Notidanus muensteri* and *N. daviesi* (Fig. 10), has the reduced cusps absent or mere serrations, and the cusps at the other side of the principal cone somewhat enlarged; but the root or base is still depressed, as in *Hybodus*. In the Upper Cretaceous species (Fig. 11) the root is compressed and deepened, and the cusps behind the principal cone are as many as seven in number; while in some Pliocene species (Fig. 12) the corresponding teeth have not less than ten cusps behind the principal cone, thus attaining the maximum complication. A few of the simpler types of teeth, of course, persist as usual until periods later than those at which they were dominant ; but the more complex teeth are invariably later than the earliest known examples of the simpler teeth.

To the present writer the evolution of the multi-cuspidate teeth of the Notidanidæ thus described appears analogous to that observed among mammalian teeth in those of the elephants. The principle that has admitted of the gradual multiplication of the plates (or ridges) in the grinders of elephants as they have evolved from the stage of the Miocene *Dinotherium* to that of the surviving species of India, may be assumed to have also governed the multiplication of the cusps in the sharks under consideration. In neither case is there any scope for a process of fusion of once-detached cusps or cones; in both cases it is obvious that changes have taken place in the formative tissues.

So far as the complication of teeth is concerned, the various processes thus appear to be the same in the highest as in the lowest vertebrates; and these are evidently to be regarded as the outcome of one fundamental law. It is singular, however, that there is as yet little or no evidence of the operation of this law in the intermediate groups of Amphibia and Reptilia, in which the dentition consists almost invariably of isolated, simple, or crenated cones.

REFERENCES.

1 **Davis, James W.**—On the Fossil Fishes of the Carboniferous Limestone Series of Great Britain. *Trans. Roy. Dublin Soc.*, ser. 2, vol. i., 1883, pp. 327–600, pls. xlii.–lxv.

2 ———.—On the Dentition of *Pleuroplax* (*Pleurodus*). *Ann. Mag. Nat. Hist.*, ser. 6, vol. v., 1890, pp. 291–294, pl. xiii.

3 **Newberry, J. S.**, and **Worthen, A. H.**—Geological Survey of Illinois, vol. ii., 1866, vol. iv., 1870.

4 **Owen, R.**—On the Mandible and Mandibular Teeth of Cochliodonts. *Geol. Mag.*, vol. iv., 1867, pp. 59–63, pls. iii., iv.

5 **St. John, O.**, and **Worthen, A. H.**—Geological Survey of Illinois, vol. vii., 1883.

6 **Traquair, R. H.**—On a specimen of *Psephodus magnus*, Agassiz, from the Carboniferous Limestone of East Kilbride, Lanarkshire. *Trans. Geol. Soc. Glasgow*, vol. vii., 1883, pp. 392–402, pl. xvi.

7 **Woodward, A. S.**—On the Palæontology of the Selachian Genus *Notidanus*. *Geol. Mag.*, dec. 3, vol. iii., 1886, pp. 205–217, 253–259, pl. vi.

———.—Catalogue of Fossil Fishes in the British Museum, part i., 1889.

A. Smith Woodward.

IV.

The Walk of Arthropods.

MODERN naturalists are often reproached with their preference for describing dead animals rather than for observing live ones. The justice of such reproof cannot be altogether denied, and it must be admitted that the knowledge of a creature's structure needs to be supplemented with a knowledge of how it lives and moves before we can claim to know it. Some years ago, we were much startled to learn that the conventional picture of a running horse represents the animal in an attitude altogether unnatural, and Muybridge's instantaneous photographs taught us how quadrupeds really use their limbs. A study of the walk of Arthropods is no less interesting, and this neglected subject is dealt with in several recent papers, in the latest of which Dixon (1) brings instantaneous photography to bear also on the problem.

Previous observers seem to have trusted to what they could actually see of an insect's progress, or to have made it record its steps by some graphic means. The most elaborate memoirs hitherto published on the subject are those of Demoor (2, 3) who has studied in great detail the locomotion of some insects, arachnids, and crustaceans. By means of suitably arranged vertical and inclined plates of glass partially covered by black paper, he compelled the creature under observation to move in a straight line, as it sought or shunned the light, and observed it through the uncovered glass. Beetles and crustaceans were made to record their steps by walking over smoked glass, and the various feet of Arthropods were dipped in different colours, so that diagrams of their relative positions were obtained. The horizontal and vertical displacements of the body were indicated by means of a stylet attached to the abdomen.

The ordinary method of an insect's walk seems generally agreed upon; it was long ago correctly described by Kirby and Spence. The first and third legs on one side move together with the second on the other, so that the creature is supported successively on one of an alternate pair of tripods; an arrangement of the highest mechanical perfection, as Demoor points out. Graber (4), Carlet (5), Lloyd Morgan (6), and Wilkins (7), all arrived at the same diagonal scheme for the walk of an insect as that now set forth by Demoor and Dixon. Demoor lays stress on the fact that each leg of

the tripod has its special function, the foremost to draw, the middle to support, the hindmost to push the body. He also describes in detail the motions of the body, horizontal, vertical, and transverse, which are such as to draw its centre of gravity towards the apex of the triangle of support, and so facilitate the fall on to the other tripod. He concludes from this that the insect progresses by a true walk—"a series of successively arrested falls." His observations seem all to have been made on beetles—*Meloë*, *Ateuchus*, and *Oryctes*, and he states that while the three legs of the set are placed on the ground simultaneously, the hindmost is not lifted until after the other two.

The photographic method adopted by Dixon enables the exact order of the motions to be made out. He used a camera looking vertically down on the animal, which ran on a white sheet of paper floating on water. Sunlight was used so that the shadows cast showed the exact position of the legs in relation to the ground. He found that while in the cockroach and the house-fly the hindmost leg is lifted last of the three, in the blow-fly it is the first to be raised. A highly interesting result is the extension of the diagonal motion to the anterior appendages, as in the cockroach and earwig each antenna and maxillary palp moves with the front leg of its side: it will be remembered that the second pair of maxillæ (labium) comes between the legs and the maxillæ, and the mandibles between these and the antennæ. It is possible that some aid to the determination of homologies may come from such observations, but it seems likely that this rule of moving in diagonals would only be obeyed by those appendages which remain functional.

Dixon has shown that the motion of limbs in diagonals is not universal in insects. An aphis and some small flies sometimes moved the legs of the same pair together, as did also the larva of a rove-beetle. That the latter mode is general among caterpillars is already well-known, and is recorded by Carlet (8); the claspers at the hinder end of the animal are moved first, and the wave of motion travels forwards. Dixon finds this motion of limbs in pairs also sometimes takes place in a thysanure (*Tomocerus*), specially when the abdominal sucker is in use. The fact that the primitive thysanure has a similar walk to the larva of higher insects is interesting and suggestive, but the median support afforded by the abdominal sucker makes such a mode of progression very natural, and the similarity may be homoplastic rather than homologous.

With regard to myriapods, Gaubert, in the memoir already referred to in NATURAL SCIENCE (p. 527), states that, while centipedes move their legs alternately, millipedes move those of the same pair together.

The walk of arachnids is described by Gaubert as produced by the motion of alternate limbs, the first and third legs on one side moving with the second and fourth on the other. This result agrees with that obtained by Carlet and Wilkins; but they seem to have

observed only spiders. Demoor's observations have been made on a scorpion (*Buthus*), in which he finds a more complicated arrangement. The second and third legs of one side are close together at the moment when those of the other are far apart; these four legs give, therefore, a triangular base of support whose apex is alternately to the right and left of the animal; the first and fourth legs of the same side move together, each alternating with its fellow, the first pair of legs, as in insects, having a tractive, the hindermost pair a pushing function. Demoor thinks that this arrangement should hold throughout the arachnids, and tries to throw doubt on the results of Carlet, who gave the regular motion of diagonal limbs as the walk of the common wheel-web spider, *Epeira diadematа*. According to Demoor, the great relative size of the abdomen in the female *Epeira* makes it an untrustworthy subject for such researches. Gaubert, however, has observed the same walk in spiders of the genus *Tegenaria*, and we may consider the results of Carlet fully confirmed, as far as spiders are concerned, by the photographic researches of Dixon. The common house-spider, *Tegenaria derhamii*, and a hunting spider, *Tarentula pulverulenta*, were observed by him, and the rule of motion of limbs in diagonals holds in both. These species are perfectly at home running on flat surfaces, and are certainly better subjects for observation than the *Epeiræ* which are rather adapted for climbing on plants or about their own webs. The female *Epeira diadematа* can run, however, over a flat surface, and seems to carry her abdomen clear of the ground. I have observed that the proportionally larger, globular abdomen of the female *E. quadrata* is at times a drag on her movements on a flat surface, and the hind legs are often not raised from the ground but simply trailed along it. If the walk of *Buthus* as observed by Demoor is representative of what occurs among scorpions generally, we must consider their mode of progression to differ from that of spiders. If all insects do not walk alike, we may naturally expect to find differences among arachnids. Dixon's observations show that while in the *Tegenaria* the wave of motion travels from the hindmost to the foremost legs, it travels from before backwards in the *Tarentula*, though in both cases there is a pause between the action of the two sets of diagonal limbs. A reduction in the time of this pause, and an extension in the interval between the motion of the first and last legs of the same set, would produce such a walk as Demoor finds in *Buthus*.

Dixon noted that a spider often uses its palps as legs, but could not determine at what time they move. Gaubert states that a palp moves with the second leg of its side; it follows, that is, the rule of diagonals.

For the walk of crustaceans we have only the researches of Demoor. The prawn, *Palæmon serratus*, generally uses six legs for walking, which move in diagonal sets as among insects. *Gebia littoralis* sometimes shows the same walk, but when wishing to emerge

from the water, while its hinder abdominal appendages are fixed to the sea-bed, it stretches its legs forwards, those of the same pair acting together, and so draws itself onwards like a caterpillar. This mode of progression is analogous also to what Dixon observed in *Tomocerus* when using its abdominal sucker. The lobster, *Homarus vulgaris*, uses its four pairs of legs in walking, according to Demoor, in much the same way as the scorpion, *Buthus*, but its limbs act with less mechanical advantage than those of the arachnid. As might be expected, the walk of crabs is irregular and complicated; the legs of a pair always move alternately, but while the four pairs sometimes follow the rule found in spiders, sometimes the walk is like that of *Buthus*, and at other times the four legs of a side are moved successively and independently. The well-known lateral motion of a crab is caused by the legs of one side acting as tractive levers, while those of the other side push.

An interesting field for research is before us in the walk of Arthropods, and there can be no doubt that photography will give us more reliable results than any other means which can be used to determine how these creatures use their wonderfully-formed limbs.

REFERENCES.

1. **Dixon, H. H.**—Preliminary Note on the Walking of some of the Arthropoda. *Sci. Proc. R. Dublin Soc.*, n s., vol. vii., 1892, pp. 574–8.
2. **Demoor, J.**—Recherches sur la Marche des Insectes et des Arachnides. *Arch Biol.*, vol. x., 1890, pp. 567–608, pls. xviii.–xx.
3. ——— Recherches sur la Marche des Crustacés. *Arch. Zool. Exp. et Gén*, 2nd ser., vol. ix., 1891, pp. 477–502, pls xix.–xxi.
4. **Graber, V.**—Der Organismus der Insekten. München, 1877.
5. **Carlet, G.**—Sur la Locomotion des Insectes et des Arachnides. *Comptes Rendus*, vol. lxxxix., 1879, p. 1124.
6. **Morgan, C. Lloyd.**—The Beetle in Motion. *Nature*, vol. xxxv., 1886, p. 7.
7. **Wilkins, A.**—The Beetle in Motion. *Nature*, vol. xxxv., 1887. p. 414
8. **Carlet, G.**—Sur le Mode de Locomotion des Chenilles. *Comptes Rendus*, vol. cvii., 1888, p. 131.

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V.

The Falling of Leaves.

IT is a matter of common observation that most of the trees in temperate climates like our own are deciduous, that is, shed their leaves at the approach of the unfavourable season to break out anew when it is past. The roughest examination of a leaf shows the reason; a delicate structure spread out to get as much air and sunlight as possible, and containing a high percentage of water, would fare badly in the frosts of winter. The plant, indeed, has often to resort to devices for protection against the cold of even a summer night, as witness the sleep movements of leaves; the false Acacia (*Robinia pseud-acacia*), for instance, dropping its leaflets into a vertical position, instead of, as in the day-time, spreading them almost horizontally to the sky. An early snow-storm shows the foliage to be actually a source of danger to the tree in winter, the great weight of snow, kept from falling by the leaves, often snapping huge branches, or bearing down the whole tree. Where leaves persist through the winter, as in evergreens, they are specially protected by a thick cuticle, and often much reduced in size, as in Pine "needles."

Common though the occurrence is, it is only in recent years that we have had anything beyond vague guesses as to the way in which it is brought about. Various suggestions were made from time to time, but they were not based on a careful investigation of the parts concerned, and were, therefore, generally valueless. Thus Duhamel (1), in his "Physique des Arbres" (1758), states that a layer of tissue between the leaf and stem remains in a herbaceous condition, and cannot stand the cold of winter; and this being the case, evergreen trees keep their leaves by reason of the point of insertion acquiring a maturity sufficient to resist the severe weather. He admits, however, that this explanation is not altogether satisfactory, for it does not explain why leaves which only appeared at the beginning of the autumn, resist the cold better than those developed in spring, whereas the latter ought certainly to be the less herbaceous, and accordingly suggests as a second cause that the leaves stop growing on account of their strong evaporation of water, while the stem continues to grow in thickness, thereby setting up a mechanical strain and tearing the fibres connecting the two members.

According to Mustel (2) (1781), the leaves cease to evaporate in

autumn, but the heat from the sun being often considerable, continues to raise the sap in the stem; the leaf, however, is already choked, and can admit no more, and so strong is the pressure of the ascending current against the petiole that it falls off. Murray (3) (1785) offers another mechanical explanation; he says the pressure of the growing bud in the axil of the leaf hinders more and more the flow of sap into the latter, causing it to die and fall off. Gerard Vrolik (4) (1797), though his explanation is based rather on analogy with animal structures than on observation, comes nearer the mark. Every organic part has its own life-period, which it fulfils, and then dies at the appointed time, independently of the duration of other parts. Premature death of the leaf may be brought about by excessive cold, heat, or disease. The separation of dead leaves is due not to mechanical causes but to the absorption of a layer between the dead and living parts yet belonging to the living part. This absorption occurs first in the cell-tissue, and later in the vascular bundle of the leaf-joint. Vaucher (8) (1821) imagined a parenchymatous tissue between the stem and leaf which, so long as it was living and succulent, strongly connected the two members. In the autumn it dried up or altered in such a way that the union was interrupted. He also believed that the fibres did not run uninterruptedly from the stem into the leaf, but were connected by a suture formed most probably of parenchyma in which the separation occurs when the fibres in the petiole die. Schultz (9) (1823) thought that the ends of the members of which he imagined the vessels composed were on a level at the place of separation, and that they became gradually shut off from each other, so that at last no flow of sap from stem to leaf was possible. He does not explain how the actual separation took place. Link (6) (1812) suggested that the direction of the cells was altered at the place where the separation ultimately took place. According to Treviranus (11) (1835) also, the cell-tissue at the leaf-joint differs from that of the rest of the organ in form, size, and direction; and when the vigour of the life-processes diminish, there is insufficient force to push the sap through the joint and the different cell-masses become separated. Schacht (13) (1859) makes leaf-fall the result of the stoppage of the flow of sap between stem and leaf by the gradual formation of a cork-layer across the joint.

Mettenius (12) (1856), who really seems to have made careful observations, states that in those ferns which throw off their leaves, the process is furthered and made possible by the death of a layer of delicate-walled parenchyma, which, in the same way as in dicotyledons, is formed between the leaf-cushion and the petiole.

Dr. Inman (14), in a short paper read before the Literary and Philosophical Society of Liverpool in March, 1848, describes the gradual formation of a "process of bark" across the leaf-joint, and also states "that the disruption takes place invariably through the cellular tissue external to the prolongation of the epidermis" or

process of bark, so that the tree does not suffer from the effects of an open wound. The change in the cellular tissue prior to its disruption he describes as a sort of self-disintegration; "the cells contract and become rounder, and separate their walls from each other, so as to destroy their cohesion." He lays great stress on the point that this separating process is a vital one, and there is no doubt that he gives the true explanation, but it is vaguely expressed, and though foreshadowing some of the results subsequently arrived at by Mohl, his work will not compare with the careful account of the German botanist to whom belongs the honour of the satisfactory elucidation of the problem of leaf-fall.

In 1859, Hugo v. Mohl (15) chanced, as he tells us, for the first time for many years to spend the autumn at home, and took the opportunity of investigating, in a number of plants, the organic changes which cause the fall of leaves. The result of his investigations will be found in the first two numbers of the *Botanische Zeitung* for 1860, of which paper he was then one of the editors. Taking *Gymnocladus canadensis* as an example, he describes the appearances noticed in the tissues of the leaf-joint between the 10th and 20th October, during which time many of the leaves lose their leaflets, and the common leaf-stalks on the lower nodes of the branches gradually drop, while those on the upper nodes are only beginning to prepare for their fall and cannot be removed without tearing the joint.

Separating the tissue of the twig from that of the leaf-stalk is a layer of cork. The tissue of the lower part of the leaf-stalk consists of shorter cells than those of the rest of the stalk or the cortex of the twig, while the lowest layer immediately above the cork also has its cell-walls coloured brown. Somewhat parallel with this brown layer, but separated from it by colourless polyhedral cells exactly similar to those forming the bulk of the leaf-joint, a thin cell-layer runs across the joint. If we examine a leaf near the time for falling, but which yet cannot be separated without irregular tearing, this layer is seen, in longitudinal section, to consist of a few cell-rows, somewhat more opaque than the rest of the tissue, in which treatment with iodine tincture reveals a fair amount of very small starch grains, absent from the rest of the tissue of the leaf-joint, a brown-staining, slimy content of a proteid nature, and a conspicuous primordial utricle. We are evidently dealing with a tissue which, in contrast with the rest of the leaf-joint, has all the characters of a young tissue —is, in fact, meristematic. Closer observation shows, in many of the cells, thin dividing walls parallel to the layer; a process of cell multiplication is evidently going on. If we examine a leaf on the point of falling, where the tear is more or less complete, we find that it proceeds from the separation of the walls of the cells of the starch-containing layer, the free rounded surfaces of which are seen lining the sides of the tear. This layer Mohl terms the "separating layer."

The result of this process is that the surface of the leaf-scar, directly after the fall of the leaf, is formed, not by the brown dying cell-layers, but by the colourless succulent living cells above these, which, however, rapidly dry up. According to Mohl, the formation of the "separating layer" begins only a short time before the fall; it was not present on October 4th. It is not formed simultaneously through the whole thickness of the joint, but starts from the inner side bounding the leaf-axil and proceeds towards the outer surface; it often happens that complete separation has taken place above, next the axil, while the under outer ridge is still firmly united to the cortex and cannot be separated without tearing. He is unable to say at what time the cork-layer was formed, as the researches on *Gymnocladus* did not extend back beyond the middle of September, when it was already present. The vascular bundles take no part in the changes which anticipate leaf-fall. They run unaltered and uninterrupted from the twig through the cork-layer, and the brown, round-celled layers above it. After the separation in the surrounding tissues they are broken in a purely mechanical way by the mere weight of the blade, or some external strain, such as wind or rain.

Thus for *Gymnocladus* Mohl shows conclusively that the separation of the leaf is the result of changes in a distinct "separating layer" which bear no connection with the previously formed cork-layers. The latter serve to protect the surface of the scar, which is consequently healed long before it is actually made.

Mohl also investigated the phenomenon in many other temperate plants with deciduous leaves, including shrubs and herbs as well as trees. In many cases the cork-layer was present as in *Gymnocladus*, but frequently it was absent; this was the case in all the ferns with deciduous leaves which he examined, in the beech, several oaks, the elm, the white mulberry, the lilac, belladonna, the tulip tree, and others. Hence, it is evidently not the cause of the leaf-fall as Schacht thought, and as is also seen from the fact that in plants like the poplars, which regularly lose their leaves from below upwards, the cork-layer is in exactly the same condition in those leaves which are about to fall and those still firmly connected; the difference lying in the "separating layer" which, while scarcely marked in the lower leaves, is completely formed in the upper. The brown coloration (suberisation) of the membranes of the round-celled layer has also no direct influence on the fall, as separation occurs above it in the still fresh and succulent part of the petiole; this layer varies greatly in size, and is sometimes quite inconspicuous.

The "separating layer" is universally present, though sometimes easily overlooked when only divided from the brown, round-celled layer by two rows of cells, in which case the tear seemed to take place between the dead tissue and the fresh, living leaf-stalk. The formation of this all-important layer usually begins, according to Mohl, a few weeks before the fall, in most cases not before the

beginning of October; he could not find it in many plants on October 5th, *e.g.*, ash, *Ampelopsis* and others, but it formed in these in the course of the next five to ten days. No definite time can, however, be given, as it depends on the weather, the position of the tree, and also varies, as, for instance, in the poplars mentioned above, in the different leaves of the same tree according to position on the twig, or whether shaded or exposed to the sun. It was quite absent, or faint traces only were present, in the almost completely dried leaves of the beech and several species of oak in the second half of October.

Mohl definitely states that only two rows of parenchymatous cells are used in its formation. When the leaf nears its fall, the cells separate without tearing and the free cells become rounded off; they are not by any means dead, but contain a well-defined layer of protoplasm and become turgid on addition of water. The transition from firm union to complete separation is, moreover, not sudden, but spread over a time during which the walls get weaker and are more easily separable. In none of the plants examined had the vascular bundles running through the joint undergone any visible change. There was no general rule as to the place of separation, except that it never occurred in the cortex of the stem, but always in the tissue of the leaf-stalk, usually in the lower region of the basal swelling. The place is not previously indicated; it appears in the hitherto perfectly uniform parenchyma of the part of the leaf-stalk.

Such is the account of the anatomical changes resulting in the fall of the leaf given by the German botanist two and thirty years ago. With a few modifications and additions it represents the present state of our knowledge.

In 1882 MM. Guignard and Van Tieghem (19) communicated to the Botanical Society of France the result of some researches conducted specially on *Gymnocladus canadensis*—the plant of which Mohl also made special use. They investigated the fall of the individual leaflets, as well as of the whole leaf, and their researches, moreover, showed the condition of the parts concerned as early as the middle of June.

As regards the leaflets, the formation of the separating layer was the only phenomenon observed, and that only a short time before the fall. A thin layer of active tissue (secondary meristem) is formed in which the cells of the epidermis, and the bast and wood parenchyma, also take part, only the sieve-tubes, the vessels, and the fibres being omitted. The separating layer consists of three rows of cells, of which the middle one is absorbed, while the walls of the upper and lower, relieved on one side from pressure, become rounded towards and press upon each other, and the tension thus caused snapping the vessels and fibres, the leaflet is literally thrown off by the force of the turgescence of the separated cells. The wound is left exposed; there is obviously no reason for the careful protection of scars on a leaf-stalk which will itself soon drop.

As regards this common leaf-stalk, an important point is the

early appearance of the separating layer. In the middle of June a transverse layer of parenchyma dies and becomes suberised, completely separating the parenchyma of the stem from that of the petiole, while leaving the vascular bundles free. This evidently corresponds to Mohl's round-celled layer, which takes on a brown coloration. Shortly after, the layer of cells in the stem immediately below it becomes meristematic, dividing centripetally by walls parallel to the layer. The daughter-cells become suberised from above downwards, and a layer of cork is formed which thickens more and more against the lower border of the first suberous layer. This cork layer is in touch with that of the stem. Thus a double suberised barrier separates the parenchyma of the stem and leaf. A little later there appears in the lower part of the petiole above the cork formation a layer of secondary meristem, quite similar to and behaving like that just described for the leaflet; it appears, however, much earlier, as it is so far, that is, on the lower surface only of the petiole, perfectly developed before the end of June. Leaves examined a month later were in the same state, which is probably maintained without change till the autumn, judging from Mohl's observations, which date from October 4th.

In the present case, leaf-fall was produced artificially by enclosing the twig bearing the leaf in a damp box. For the first five days no alteration was visible, but on the sixth the blue line produced in staining a longitudinal section with iodine tincture, which marks the layer of separating meristem, had progressed upwards, traversed the vascular bundles, and reached half-way to the upper epidermis. On the seventh day it had quite reached the latter as in the leaflet. The central row of cells is absorbed, those of the upper and lower layers becoming turgid, press on each other, causing the vessels and fibres to snap, and the leaf falls. The parenchymatous cells of the end of the bundles exposed on the scar become meristematic and form a cork layer and also grow into the vessels, filling them with tissue (tylose), so that the wound is soon covered by a continuous cushion of cork.

The account of MM. Guignard and Van Tieghem suggests several modifications of that given by Mohl:—

1. The very early appearance of the separating layer in the lower region of the petiole.
2. The similar early appearance of the suberous layer, the true nature of which Mohl did not appreciate, and also of the underlying cork, which he merely states to have been present at the commencement of his researches.
3. The mode of separation which, according to Mohl, occurs without cell-destruction, the layers merely separating from each other; whereas the two later observers speak of the absorption of an intervening layer.

The French botanists also investigated the process in other leaves and leaflets. They found that all the leaflets fall as in *Gymnocladus*

canadensis, while as regards the fall of leaves two methods are to be distinguished. The first, as in *Gymnocladus*, with a previous cicatrisation of the wound; the second as in the leaflets of *Gymnocladus* and leaflets in general, that is with no trace of previous cicatrisation, the wound healing only slowly, remaining for some time exposed as a nidus for spores of parasitic fungi. There are also intermediate cases.

Further researches are needed to show whether the absorption of the median layer is universal, or whether the separation may take place according to both methods. Strasburger (20), describing the leaf-fall in the horse-chestnut in his "Botanische Practicum" (1884), says, p. 241: "The separation takes place inside the separating layer, the cells of which round off against each other and become disconnected"; and Hillhouse, in an editorial note in the English translation of the same, mentions that researches undertaken in 1882 at Bonn, under Strasburger's guidance, and still continued, have led to practically the same result. Bretfeld (18) who investigated the process of leaf-fall in the tree-like monocotyledons, orchids, and aroids, finds that the separating layer in these plants is a still earlier formation, being produced at the same time as the leaf itself in the general tissue-differentiation.

In the case of evergreens, where the leaves are so protected as to be able to withstand the winter cold, the plant is always in leaf. Every season, however, some of the older leaves fall, while new ones are regularly produced. The number of seasons for which they last varies with the species in question; in *Skimmia japonica*, a shrub frequently seen in London parks, leaves will be found on the growth produced the year before last, and Mohl says he saw leaves on eleven-year old shoots of the Silver Fir in the Black Forest.

It is interesting to note that, where the function of the leaves is for some reason performed by another organ, phenomena analogous to leaf-fall may also supervene. In some species of *Rubus*, the blackberry genus, the leaves are reduced to thorns, and the function of assimilating carbonic acid from the atmosphere is performed by the green cortex of the stem. F. W. Oliver (21) has shown that in *Rubus australis* the assimilatory layer is cut off annually by a layer of cork, and that a similar case occurs in *Casuarina*, where the longitudinal ridges on the stem form the chief assimilatory tissue; these ridges are cut off every year by a cork layer and begin to scale off in the second year.

It is well known that a sudden frost in autumn often causes a copious leaf-fall. Mohl (15), in investigating this point, found a thin sheet of ice on the surface of the leaf-scar, while other leaves which were still attached to the twig were, however, quite separated from the leaf-scar by a similar ice-sheet, to the upper surface of which they were frozen. Closer examination showed the ice-sheet to be formed in the separating layer, the cells of which, being actively living, are more delicate and contain more water than the surrounding tissue,

and are hence more susceptible to frost. Examination of the leaf-scar often showed torn fragments of tissue attached thereto, evidence that the separation had been a violent one.

In a paper on the parts involved in the process of defoliation, McNab (16) argues that it is not a separation of the leaf from the axis bearing it, but of one part of the leaf from another, the "epiphyll" from the "hypophyll."

His view is based on a theory of Eichler's, that the leaf consists from its earliest appearance of an upper and a lower portion; from the upper, epiphyll, the stalk and blade are developed, while the stipules are appendages of the lower, hypophyll, which is a part of, and adherent to, the axis and ultimately forms the leaf-scar. This would explain why the stipules sometimes remain after the fall of the leaf, as in *Mimosa*; usually, however, they fall sometime before, having served their purpose as protective organs to the developing leaf. This is a question of morphological interest, but the results hitherto obtained show rather that the separating layer is a new formation appearing somewhere, but at no very definite place, in the lower part of the leaf-stalk, and not marking the line of some previous morphological division.

While the production of the separating layer is the first cause of the leaf-fall, external conditions have also great influence on the process. In still weather a very slender attachment may suffice to support the leaves, which the force of a heavy shower or a gust of wind would speedily send to the ground. In a large town like London, where the air is vitiated by smoke, the leaves will fall sooner than in the pure open country. The glorious autumn tints are also absent, or but feebly reproduced in town, the yellow, orange, or crimson colouring giving place to a dry rusty brown. In a Midland pottery town where manufacturers run riot and sneeze at anti-smoke legislation, the leaves fare worse still, and half-way through September don a jaundiced hue and drop sadly to the ground, or shrivel miserably on the branches.

Climate has naturally a great influence on the length of time during which the leaves will remain attached. Where the autumn is prolonged the foliage will also last. Thus for the neighbourhood of Naples, excepting years when the winter sets in unusually early, Tenore quotes the end of November for the defoliation of the walnut, ash, lime, oak, and poplar, and states that the leaves of the apple, beech, elm, and birch often last till the end of December. Foliage generally will keep longer in a damp, sheltered spot than in dry, sunny, exposed positions, and longer after a wet than a dry summer. All the trees do not lose their leaves at the same time; the oaks and elms are still green when the chestnuts and limes are almost bare. Apart from conditions of climate or weather, each species has its own peculiarity in this regard. This may sometimes be due to the fact that species now growing together in one country have come

originally from somewhat different climates. A plant may have contracted the habit through long generations of shedding its leaves early or late, as the case may be, and retain the habit under changed conditions. Thus De Candolle (17) explains early leaf-fall in some cases by introduction from an extreme climate where it would be necessary, and instances the walnut introduced from Armenia, and the *Catalpa* and *Gleditschia* from the eastern United States.

The question also arises whether plants which come into leaf early in the spring lose their leaves early in the autumn, and whether the late leafers are also tardy as regards defoliation; or whether some other combination obtains, and the early leafers are late to lose their leaves. The hawthorn hedges are among the first to show signs of green in the spring, and among the last to lose their foliage in the autumn. The horse-chestnut buds have burst when the oak and ash are as grey as midwinter, but the latter retain their leaves the longer; we must remember, too, that like many of our trees they get their flowering over before leafing, while in the chestnut the leaves are the first developed. However, as De Candolle remarks, we cannot draw conclusions from stray instances, but must take the mean of researches extending over some time. He accordingly takes the *résumé* of four years' observations (1841–44) given by Quetelet (22) in his report on the climate of Belgium. Thirty-eight species or good varieties were observed. De Candolle makes four lists, A, B, C, D. In A he includes the early leafers, in B those with an early leaf-fall. C comprises the late leafers, and D those where the fall is late. Each list contains about thirteen names. Two, *Spiræa sorbifolia* and the lilac, *Syringa vulgaris*, are common to A and B—that is, out of thirteen early leafers only two lose their leaves early; four are common to A and D, leaf early, but have a late fall; two, the walnut and *Gleditschia ferox*, are common to B and C, having an early leaf-fall though leafing late, and four are late in leafing, and have also a late leaf-fall. It is evident that there is no real connection between the two epochs; the leaf-fall is independent of the previous budding.

De Candolle also quotes observations on individual trees as to whether, for instance, any one chestnut which came into leaf early would be earlier or later than others in shedding its leaves.

In many species, like the horse-chestnut, beech, elm, &c., trees growing side by side, planted at the same time, and subjected to the same external conditions, neither come into leaf nor lose their leaves simultaneously. These facts of idiosyncrasy, he says, are constant. They recur always in the same manner year after year, even when the differences in time are reduced to two or three days. Are the individuals which first come into leaf also the first to lose their leaves? or is the inverse the case? Some facts are given for the horse-chestnut, where the difference between individuals is very marked. Of three old trees in the court of a country house at Frontenex, the owner stated that for years they followed the same order of succession at both

epochs, those which were the first to leaf were also the earliest to lose their leaves. A chestnut in the garden of the Tuileries, from its habit of early leafing, is known as the Vingt Mars, and M. Henri Vilmorin states that, compared with the other chestnuts in the gardens, it keeps its leaves beyond the mean time of leaf-fall. M. Vilmorin also observed thirty-four horse-chestnuts 150 years old in a plantation on his own property at Verrières in 1876 and 1877. He found that those which were the first to lose their leaves in 1876 were again in the same category next year, with slight differences as to order. Six of those which were the first to put out leaves in spring were late to lose them in autumn, while five others were early in leaf and early in losing leaf. He concludes that the two phenomena have no regular relation. A tree which is a precocious leafer in the spring may either be early or late in shedding its foliage in the autumn. He found, however, that in the majority of cases lime trees (*Tilia platyphylla*) which were early to leaf were late in losing leaf. Observations on the beech and elm, the latter at Geneva, showed, as in the case of the chestnut, no relation between the two phenomena.

In conclusion, we may notice how plants utilise the fact of their leaves being merely temporary structures. Leaves share with the bark (also transient) the functions of the excretory organs of an animal; in their cells the plant deposits those by-products and residues from the chemical life-processes of which it can make no further use, and which are thus got rid of when the leaf falls. A leaf which has run out its full time and then been dropped, will contain quantities of calcium oxalate, resinous and gummy matter, and often alkaloids, such as nicotine, thein, and others, which form the nitrogenous excreta of plants. On the other hand, useful matter like starch, sugar, and proteid has been gradually removed and passed back to the stem.

REFERENCES.

1. **Duhamel du Monceau.**—La Physique des arbres. Paris: 1758, vol. i., p. 129.
2. **Mustel.**—Traité théorique et pratique de la végétation. Paris and Rouen: 1781–84.
3. **Murray, J. A.**—Opuscula, vol. i., p. 138. Göttingen: 1785.
4. **Vrolik, Gerard.**—Observationes de defoliatione vegetabilium. Leyden. 1797
5. **Senebier, J.**—Physiologie vegetale Geneva: 1800, vol. iv., p. 238.
6. **Link, H. F.**—Bemerkungen und Zusatze zu K. Sprengel's Werk über den Bau u. die Natur des Gewächse. Halle. 1812.
7. **Du Petit Thouars, A.**—Histoire d'un morceau de bois. Paris 1815, p. 180.
8. **Vaucher, J. E. P.**—Sur la chute des feuilles Mémoires de la societé de physique et d'histoire naturelle de Genève, vol. i (1821), p. 120. An account of this paper is contained in the *Edinburgh Journal of Science*, vol. v. (1826), p. 330
9. **Schultz, K. H.**—Die Natur der lebendigen Pflanze Berlin 1823, vol. i., p. 248
10. **De Candolle, A. P.**—Organographie vegetale. Paris, 1827, vol. i., p. 133
11. **Treviranus, L. C.**—Physiologie des Gewächse, Bonn, 1835, vol. i., p. 435, vol. ii., p. 216.
12. **Mettenius, G.**—Filices horti botanici Lipsiensis. Leipzig: 1856, p. 18.

13. **Schacht, H.**—Lehrbuch der Anatomie u. Physiologie des Gewächse. Berlin: 1859, vol. ii., p. 136.

14. **Inman, T.**—Proceedings of the Liverpool Philosophical Society, vol. iv. (1848), p. 89, reproduced in Henfrey's *Botanical Gazette*, vol. i. (1849), p. 59.

15. **Mohl, H. von.**—Ueber die anatomischen Veränderungen des Blattgelenkes, welche das Abfallen der Blätter herbeiführen. *Botan. Zeitung*, vol. xviii. (1860), pp. 1, 9.

Also Einige nachträgliche Bemerkungen dazu. *Ib.*, p. 132

Also Ueber den Ablösungsprocess saftiger Pflanzenorgane. *Ib.*, p. 273.

16. **McNab, W. R.**—On the Parts Involved in the Process of Defoliation. *Transactions of the Botanical Society of Edinburgh*, vol. viii. (1866), p. 381.

17. **De Candolle, Alph.**—Feuillaison, Défeuillaison, Effeuillaison. *Archives des Sciences Physiques et Naturelles*, vol. lxii. (1878), p. 143.

18. **Bretfeld, F. von.**—Ueber Vernarbung und Blattfall. *Pringsheim's Jahrbuch für Wissenschaft-Botanik*, vol. xii. (1879–81), p. 133.

19. **Guignard, L., and Van Tieghem, Ph.**—Observations sur le mécanisme de la chute des feuilles. *Bulletin de la Société Botanique de la France*, vol. xxix. (1882), p. 312.

20. **Strasburger, E.**—Das botanische Practicum. Jena, 1884. English Edition by W. Hillhouse, London, 1887.

21. **Oliver, F. W.**—Phenomenon analogous to Leaf-fall. *Annals of Botany*, vol. i. (1887–88), p. 71.

22. **Quetelet.**—Climat de la Belgique, 1846; do., 1860.

23. **Fritsch, K.**—Phänologische Beobachtungen. Vienna, 1857.

24. Osservazioni fenoscopiche sulle piante. Ministero di Agricoltura, &c., Rome, 1887.

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VI.

Norwich Castle as a Museum.

THE most salient features which, from a distance, mark the site of the ancient and picturesque City of Norwich are its cathedral spire, and its still more venerable castle, the donjon-keep of which forms a striking object for many miles around. Long before the Romans had set foot in Britain this spot had been selected by the Iceni for a British village, and the elevated peninsula of land, almost encircled between the rivers Yare and Wensum, had presented to these early and warlike people a favourable site for a stronghold where, enclosed by earthworks, defended by wooden palisades, and encircled by ditches, they might well defy the incursions of neighbouring tribes as restless and as hostile as themselves.

There is no evidence of Roman masonry in the castle walls, but the neighbouring camp at Caister was doubtless maintained to overawe the district, and they may have fortified the earthworks of the British station, and even kept a part of their garrison there; for all the old Roman roads in Norfolk must have radiated from Caister or Norwich (then the *Venta Icenorum*), proving that it was a place of great military importance in the Roman period.

As the earlier occupiers, the Danes and Saxons, mostly *built in wood*, we shall be justified in concluding that nearly the whole of the present castle[1] is of Norman origin.

Uffa, first king of the East Angles, built the earliest structure here, A.D. 575, but this was destroyed by Sweyn, king of Denmark, in 1003, in revenge for the massacre of the Danes in the previous year; but in 1011 the Danes themselves rebuilt the castle and city, and Norwich, for the time, became a Danish stronghold. Canute, it is stated, erected another building here about 1018, but the present castle was probably built soon after the Norman Conquest.

The following inscription is placed on the eastern face of the keep:—

"This Royal Castle, built by William Rufus, as Knyghton testifies in his Chronicles, on the site of one much more ancient, has been used as a county gaol since the year 1345, and was finally vested in the Magistrates of Norfolk for that purpose by a Royal Grant, confirmed by Act of Parliament in 1806.

"The ornamental work and facing of the exterior having fallen

[1] Except the rubble flint-work foundations, the lower course of the keep, and the bridge over the moat, which is the largest arch extant in this country attributed to the Saxons.

into a state of extreme decay, the same were ordered to be restored, at the expense of the county, by the Court of Quarter Sessions, in April, 1834. This restoration was carried into effect, with the most careful adherence to the details of the ancient work, in Bath stone, as most resembling that of Normandy, which had been originally used, under the superintendence of the visiting Justices, and completed in 1839.

"The battlements and corbel table were designed from the best discoverable authorities, as no portion remained of the original termination to the building.

"Anthony Salvin, Esq., London, Architect.
"Mr. James Watson, of Norwich, Stonemason."

Notwithstanding this bold assertion upon the wall of the keep, on Knyghton's authority, it is very doubtful whether the building was erected by William Rufus, or in his reign. Antiquaries for the most part agree that a strong fort of some kind occupied the site before the Conquest, the inner moat and arch of the bridge being considered of Saxon date. It is also certain that William the Conqueror built a strong Norman castle on the site, which stood, under the leadership of Emma de Guader, Countess of East Anglia, a three months' siege by his own troops, aided by the best artillery of the day, and could not have been destroyed by the siege, as, when it was taken, a garrison of three hundred men was thrown into it. It seems most improbable, therefore, that a new castle should have been erected fifty years later by William Rufus; it would be more probable that the one built by the Conqueror was enlarged and added to, notably by the portion known as Bigod's Tower, &c.[2]

Whether the enclosure was surrounded by three distinct trenches has been disputed,[3] but portions of outer entrenchments have been discovered by Mr. Boardman and others, and it is interesting to notice that the innermost and deepest of these moats still remains, being planted with trees and shrubs, and converted into a very pleasant public garden, at the base of the circular and elevated plateau, upon the level summit of which the castle is built.

The great keep, which stands at the south-west angle of this plateau, is a massive quadrangular pile measuring 110 ft. in length from east to west, 92 ft. 10 ins. in breadth from north to south, and 69½ ft. in height to the top of the merlons of the battlements, the walls being from 10 to 13 ft. in thickness. The only apertures in these huge walls are loop-holes at intervals, used for purposes of defence, and also to admit light to the interior apartments; but the solid walls of the exterior were relieved by ornamentation with string courses and semicircular arches resting on small three-quarter columns.

On the east side of the keep there is a projecting tower, called

[2] For this critical and thoughtful note I am indebted to Miss M. M. Blake, of Sprowston, near Norwich, who is at present engaged on a history of Norwich Castle.

[3] Many Archæologists are inclined to adopt Mr. Harrod's view ("Castles and Convents," pp. 133–39), that a large horseshoe-shaped fosse extended to the south of the existing circular one, as in the case of Castle-Acre, Castle-Rising, and other places where Norman architects availed themselves of existing forts.

"Bigod's Tower," probably built by Hugh Bigod, third Earl of Norfolk, who succeeded his brother as High Constable of the Castle early in the 12th century. This tower, which was an open portal to the grand entrance of the castle, is of a richer kind of architecture, and in the genuine Norman style. Since 1824, it has been entirely restored so as to exhibit its pristine aspect, which certainly differs from the rest of the keep. The beautiful arch in this tower, and the galleries on the same level, giving access to the loop-holes and furnished with seats for the archers, are, together with the staircases in the angles, about the most interesting portions of the building to the archæologist, as they still bear the marks of the Norman chisels.

During many succeeding reigns, the castle was principally used by the sovereign for the reception of State prisoners, and was held by the king's Constable, and afterwards by the Sheriffs for Norfolk and Suffolk, who were expected "to keep it in repair and competently fortified with victuals and other things necessary and convenient, lest danger might threaten the king." (Edward II., 1308.)

Notwithstanding the king's commands, the citizens of Norwich having, in 1294, begun to enclose their city with walls and gates, the castle, which had up to that period been considered the defence of the city, became neglected, and in its subsequent history, from 1345, must be considered simply as that of the county gaol, and its jurisdiction vested in the Sheriffs of Norfolk and Suffolk as custodians for the sovereign for the time; and so it remained for the next 500 years, save that in 1805 his Majesty King George III., having no use for the place, "freely gave this ancient and royal demesne in the county of Norfolk, to be and remain in the possession of the high sheriff and justices of the peace of the county of Norfolk, for the administration of justice, the freedom of elections, and the confinement of the county prisoners." (S. Woodward.)

The plateau on which the castle stands is more than six times the area occupied by the keep itself, and on this plateau (once the inner bailey of the castle) the original county prison and shire-house were situated. These were replaced by new prison buildings in 1824–28, and the keep refaced and restored 1834–39. In 1887, the county prison having been removed to Mousehold, the buildings were purchased of the Government by the Corporation of the City of Norwich for the sum of £4,000.

It was about this time that Mr. E. Boardman, F.R.I.B.A., the City Architect, submitted a plan to the corporation, which he had cherished for many years, by which he proposed to utilise the old prison buildings and the Norman keep on the Castle Hill, and convert the whole into a magnificent museum of science and art for the city, preserving at the same time the most ancient building, "the keep," rescuing it from further decay, and from its former degradation as a prison, and restoring it as an ancient historical monument, to an honoured place among the chief public buildings in the city.

On the 19th October, 1886, at a meeting of the Town Council of Norwich, the late Mr. John Gurney, being then Mayor of Norwich, proposed the conversion of the keep and prison buildings into a museum, with a view to the transfer of the collections now belonging to the Norfolk and Norwich Museum. A committee, known as the Castle Museum Committee, was appointed for the purpose of raising the necessary funds, &c., and to this fund Mr. Gurney contributed £5,000.

Since that date the Castle and all the buildings attached to it have been leased to fifteen trustees, namely, five for the Corporation, five for the shareholders of the Norfolk and Norwich Museum, and five for the subscribers to the Castle Museum Fund. When the scheme is completed, the trustees are to make over the building and collections to the Corporation, who have agreed to accept the trust, and to hold the same for the permanent scientific and educational use of the citizens of Norwich, and to maintain and preserve the said collections and utilise them for the purposes of science, literature, and art, and provide out of the Corporation funds for such purpose.[4]

Various meetings have been held, under the presidency of Lord Walsingham, supported by H.R.H. the Prince of Wales, Lord Leicester, the Lord Lieutenant (Sir Edward Birkbeck, M.P.), the High Sheriff of Norfolk (S. Gurney Buxton, Esq.), the city and county members, the Mayor and Sheriff of Norfolk, and, indeed, all the most influential people in both city and county.

Some £15,000 will be required to complete the buildings, and the sale of the present museum premises, it is estimated, will provide funds sufficient for the furniture and fittings of the new museum.

The adaptation of the whole of the buildings to the purposes of the museum has now been carried into effect, and the writer had the pleasure of seeing the entire series of galleries in an advanced state towards completion in August last.[5]

To such noble proportions may a museum attain, which, in February, 1825, had its initiation in a small body of private gentlemen, naturalists and antiquaries, connected with the city and county, starting with an annual subscription of five shillings each member.

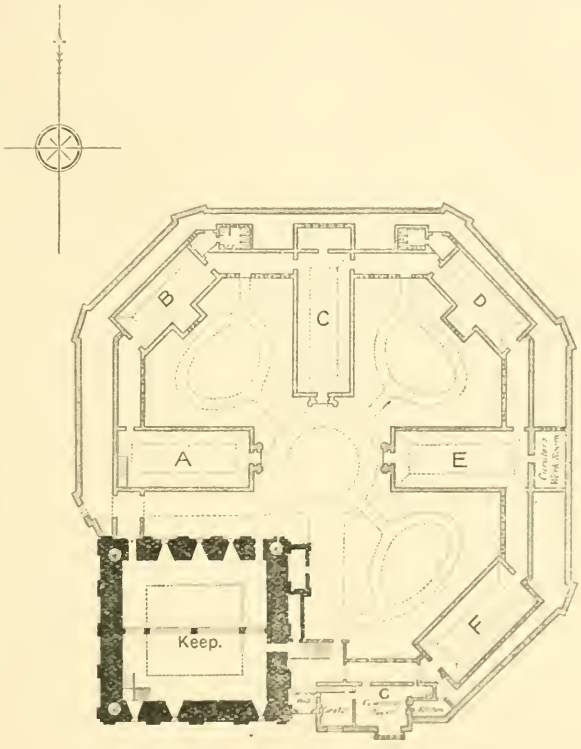
At the end of 1826 we find the Committee appealing to their friends for aid, with a debt of nearly £400, and a collection moderately valued at £850. It is to the honour of these gentlemen and their friends and successors that the Norfolk and Norwich Museum has contined (supported by voluntary contributions) for nearly seventy years, and has, at the present time, in addition to its books

[4] These particulars were kindly sent me in a letter by Mr. John Quinton, Librarian, Norfolk and Norwich Library, Norwich, to whom I am much indebted.

[5] Upon this occasion, and also in March last, I received the greatest kindness and attention from Mr. E. Boardman, Mr. James Reeve, Mr. Eaton, the Honorary Secretary, Mr. Southwell, Mr. Mottram, and other members of the Committee of the N. and N. Museum.

and pictures, its antiquities, its recent and fossil collections, a fine series of British and foreign birds, and the finest collection of raptorial birds in the world, formed and presented to the Norfolk and Norwich Museum by the late John Henry Gurney, Esq.

In the Geological Collection are preserved the grand series of Mammalian remains from the Forest Bed deposits of the Norfolk coast, formed by the late Mr. John Gunn, F.G.S.; the Chalk and Crag Collections of the late Mr. Samuel Woodward, besides those collected and presented to the Museum in recent years by Mr. James Reeve, the present indefatigable curator. The historical and figured specimens preserved in the Norwich Museum,



Plan of Norwich Castle Museum.

must be of immense value, and tend to give it a very high rank among our provincial collections.

A most valuable Report was drawn up and presented to the Castle Museum Committee by Dr. P. Lutley Sclater, F.R.S., the Secretary of the Zoological Society of London, dated June 18, 1891, on the requirements of the present collections and their proposed arrangement in the new building. As Dr. Sclater's recommendations were adopted by the Committee in July, 1891, we may conclude that they will be carried out as far as possible when the removal takes place.

The illustration is a ground plan of the inner-bailey, occupying the mound of the Castle Hill. This plateau is 350 ft. long from north to south, and 340 ft. wide from east to west. A promenade of varying width, from 20 to 30 ft. broad, surrounds the exterior of the enclosure, bordered by palisades and overlooking the Castle garden, which, as already stated, occupies the inner moat around the Castle. The keep itself stands near the south-west angle of the hill, having two of its sides exposed, but its north and east faces are enclosed within the precincts of the inner bailey courtyard. The original castellated granite wall of the prison has been preserved and is 20 ft. in height, and (save at the south-west angle, where the keep projects, forming a right angle) is roughly octagonal in form, as seen in the ground plan. The area thus enclosed is about one and a-half acres in extent.

"On entering the castle through the old prison gateway," says Mr. Boardman,[6] "we find ourselves in a vestibule, 28 ft. by 17 ft., having a handsome stone staircase six feet wide, by which entrance is gained to the keep on the left hand, and an archway leading to the enclosed gardens in the centre. The entrance-hall and all the galleries of the museum have been laid with handsome tessellated pavements, similar to that of the Great Hall of the British Natural History Museum in Cromwell Road."

Turning to the right is a corridor, 10 ft. wide and about 50 ft. long, on the right hand side of which is the Curator's room and the Committee room and library (Room G on plan). Over this latter apartment has been constructed a muniment room, with floor and roof formed of iron girders and concrete, so as to render it fire-proof, to be devoted to the preservation of all the deeds and charters belonging to the Corporation.

The first pavilion is entered at the end of the corridor. It measures 54 ft. long by 27 ft. wide (Room F on plan). This gallery is connected by a corridor 14 ft. wide by 40 ft. long, with a second pavilion 68 ft. long by 27 ft. wide and 25 ft. high (Room E on plan). A similar corridor communicates with a third pavilion (D on plan) of corresponding dimensions to the first (Room F). At the end of the second large room (Room E) is the Curator's work-room, constructed with a gallery round it, with large north lights, and fitted with wall-cases and cabinets to contain the large collection of unmounted bird skins. The fourth pavilion (Room C on plan), of similar dimensions to Room E, it is proposed to devote to a picture gallery. The fifth and sixth pavilions (Rooms B and A on plan) correspond in proportions with Rooms D and E, already noticed, and a small connecting room unites this fine series of galleries with the keep, which we enter by a doorway formed in the north wall.

The interior of the keep measures 80 ft. by 76 ft., and a gallery has been constructed around it, on a level with the principal (*ancient*) entrance from Bigod's Tower, about 12 ft. in width. Columns and

[6] *See* Report of his lecture, *Norfolk Chronicle*, November 29, 1890.

arches of stone support the roof which now encloses the keep, partly slated and partly glazed to light the interior. The pillars and arches supporting the roof are placed in accordance with the original disposition of the roof, "visible marks of the strong partition-wall running across from west to east" having existed prior to the erection of the new roof (King, Archæol., vol. iv., p. 403, 1776). Mr. Boardman also discovered (after the removal of eight feet of soil from the interior of the keep) the lower part of the ancient central wall, six and a-half feet in thickness, which ran from east to west and divided the keep into two equal parts. In the northern division he had exposed the foundations of four stone columns which formerly supported the arches or vaulting forming the main floor of the keep. The spiral stairs in three of the four angles remain, and one of them gives access to the roof, from which a grand panorama of the city and the country far and wide can be obtained; while, by descending, we reach the dungeons of the keep and the castle well, about 120 ft. deep, excavated in the chalk.

The keep will probably be devoted to the exhibition of the Ethnological collections and local antiquities, in which latter the Norfolk and Norwich Museum is very rich. Abundant floor-space will also be afforded for the holding of soirées and other scientific gatherings. The small room (leading from the keep to Room A) will, it is proposed, be devoted to the exhibition of Mr. Robert Fitch's collection (partly antiquities, and partly consisting of fossils, from the immediate vicinity of Norwich) recently presented to the Museum.[7]

The fine top-lighted Gallery A will probably be devoted to the exhibition of the geological collections, including the famous mammalian fossil remains, presented by the late Mr. John Gunn, from the Norfolk Forest Bed series. Gallery B will probably be devoted to the collections of recent Invertebrata (Insecta, Crustacea, Mollusca, Corals, &c.), and will also contain the Pisces and Reptilia.

Here the Picture Gallery (Room C) intervenes, but it has been suggested by the architect that a fine connecting corridor may be made in the rear of Block C, so that the Natural History student may pass on to Gallery D, and take up the continuous arrangement of the zoological collection without passing through the Picture Gallery. This room (D) will probably be dedicated to the stuffed specimens of recent Mammalia and their skeletons, and to other zoological specimens.

It has been suggested by Dr. Sclater that Gallery E should be entirely devoted to the magnificent and unique collection of Raptorial Birds formed by the late Mr. John Henry Gurney, and in order that the whole series may be placed in one room, a light iron gallery is to be constructed around this pavilion, which will thus afford greatly increased space for wall-cases, and enable all the specimens to be well seen and *properly arranged*.

[7] Mr Fitch also gives £300 to provide exhibition cases for his collection

Dr. Sclater mentions in his report that the "Gurney Collection" of Raptorial Birds, at the present time, consists of 3,259 specimens mounted, and 1,345 unmounted specimens, and, with the possible exception of the series in the British Museum, is the finest and most nearly complete collection of its kind at present existing. He recommends that the Diurnal Birds of Prey should be so arranged as to commence on the right-hand side of the corridor as we enter from Room F, be continued all round the ground floor of Room E, and finish on the right-hand side of the corridor leading to Room D. The Nocturnal Accipitres, which are only one-third of the number of the Diurnal Birds of Prey, may be conveniently arranged in the gallery of Room E. "This room," he adds, "I consider to be excellently lighted, and generally well adapted for the exhibition of the great Gurney collection."

Accommodation will also be afforded in the adjoining Curator's room for the Bird skins and duplicates preserved for study purposes, and for the Taxidermist. The connecting corridors to the north and south are to be devoted to birds'-nests and eggs, and to special groups, as, for instance, the fine series of examples of the now extinct Norfolk Bustard (*Otis tarda*), once a denizen of West Norfolk, Wilts, Dorset, and Yorkshire. Room F, it is suggested, should be devoted to as complete an exhibition as possible of the Norfolk fauna generally, and probably a cabinet for the flora also.

This sketch of the general arrangement of the Museum collections is of course *only tentative*, and has been partly pointed out to the writer by Mr. James Reeve, the curator of the Norfolk and Norwich Museum, and in part gleaned from Dr. Sclater's valuable report already referred to. Much must, of course, remain to be fully considered and worked out in detail when the actual time for the removal of the collections arrives; but the Committee will have to very speedily decide as to the exact appropriation of the galleries, because the making of the cases must be put in hand, both for walls and floor spaces; and although the table cases can be afterwards shifted about and transferred to suit change of plan, the wall cases, *being fixtures*, must be designed for the several rooms, and with suitable regard to the size and nature of the objects to be exhibited therein. The greatest praise is due to Mr. E. Boardman, the City Architect, for having initiated the idea of converting the series of prison-blocks into Museum Galleries, whereby hundreds of pounds have been saved, and dry, well-seasoned, and strong walls secured for the galleries, which are certainly not liable to crack and settle, as has frequently happened in many modern buildings. Admirable work-rooms and studies are also provided, and, between the blocks and the outer enclosing wall, ample unoccupied space remains for any number of additional private rooms to be constructed at a small cost. The inner area of the courtyard is being laid out as a very pleasant garden, where, instead of the "Gallows-tree," sweet flowers and shrubs may grow, sheltered

from the wind, yet open to the sun and air. The Castle Museum Committee are also happy in having the Lord Walsingham for their Chairman, one who is himself a Norfolk man, and an ardent naturalist, and who has, by his princely contributions to the British Museum of Natural History, of which he is a Trustee, abundantly proved his generosity and disinterestedness in public matters.

The Committee of the Norfolk and Norwich Museum have acquired their new building at a fortunate time, for they have no need to make expensive experiments in furniture and fittings. All such trials have been made for them in the new Natural History Museum, Cromwell Road. They may there see, not only what is good to imitate, but also what to avoid in the fitting up of exhibition cases; and by careful study of work already executed they may make the Norfolk and Norwich Museum not only a grand historical museum, which it is certain to become, but also the finest and most approved provincial museum of Natural History in the kingdom.

To the Worshipful the Mayor and Corporation it may also be desirable to mention that although they have acquired the finest historical building and the most commanding site within the ancient city of Norwich for a museum, yet that museum, when completed, cannot be maintained creditably unless the Corporation are prepared by a *liberal provision* from the funds at their disposal (and under the Libraries and Museums Act) to provide it with a proper staff of officers, men who by their training and qualifications are fitted efficiently to carry on the work of curating the treasures which have occupied so many years in collecting. Nor should they ever allow the museum of their venerable and historical city to become a mere "Old Curiosity Shop," but rather strive to make it a grand educational centre, so that, like the beacon-light which shone from its "keep" in days of old, its light and culture should radiate over the whole city and county, and many names be added to the list of Norfolk and Norwich worthies among the future, as there have been in the past generation of its citizens.

HENRY WOODWARD.

REFERENCE.

For some account of this ancient building, see the "History and Antiquities of Norwich Castle," by Samuel Woodward, of Norwich, 4to, 1830 (edited by B. B. Woodward). London: 1847. Nichols & Son, Parliament Street, and Charles Muskett, Norwich

SOME NEW BOOKS.

Animal Coloration. By Frank E. Beddard, M.A., F.R.S. Pp. 288, with four coloured plates and woodcuts. London; Swan Sonnenschein & Co., 1892. Price, 10s. 6d.

The author of the above work resembles the enterprising advertiser, in that he supplies a long-felt want, and differs from him by not having any unfailing nostrum to inflict on suffering and scientific humanity; for Mr. Beddard aims in his book rather at an impartial *résumé* of the facts for the benefit of the intelligent lay reader, than at the promulgation of any new scientific views on this difficult subject. It must not be supposed that because the aim of the book is popular it is not of serious scientific value, for in addition to many new facts it gives an all-round account of the facts of coloration as at present known, which is invaluable for reference. A general review of these opens the book, and occupies a long introductory chapter. The direct influence of environment of coloration is next dealt with at considerable length, and many interesting facts are adduced to show that this, and not Natural Selection, is the cause to be assigned for some groups of colour phenomena. Such are the loss of colour in the Scarlet Ibis in confinement, and the heightening of it in the cayenne-fed canary; the influence of humidity in producing dark colours in insects and reptiles; the existence of brilliantly-coloured animals out of the tropics; and so forth. It is well remarked, with reference to some colour changes, which appear to correspond to the seasons, that these may have some connection with the renewal and decadence of sexual activity. It has been stated with regard to male ducks, which, curiously enough, *lose* their bright plumage at the commencement of summer, that this change does not take place in unpaired birds. In the next chapter, which deals with protective coloration, comes an instance which might, perhaps, be to some extent placed under the former category, namely, the general tawny colour of desert animals, which might possibly be to some extent due to bleaching; pigeons of a tawny colour, for instance, being much affected by exposure to the sun.

It is well said that one would rather expect brilliant coloration to be the rule among nocturnal insects, seeing that all colours would be invisible at night, and the most glaring do their possessors no harm. Yet the dull colours of moths, as distinguished from butterflies, are among the tritest of zoological commonplaces, and Mr. Beddard's suggestion that their reference is to protection in the daytime seems very reasonable. While admitting the wonderful special resemblances exhibited by many animals, such as the giraffe and the Lappet moth, to their surroundings, Mr. Beddard very pertinently asks whether, as a matter of fact, animals are concealed by their protective resemblances from their foes, and points out that a complete answer to this cannot yet be given; for, as he shows, there is always too great a tendency to endow animals with senses exactly similar

to those possessed by ourselves; and yet in many cases we do not anthropomorphise sufficiently. As Mr. Beddard, a little further on, asks: "Judging of birds by our own standard—which is the way in which nearly all the problems relating to colour have been approached—does it seem likely that we should fail to see a caterpillar, perhaps as long as, or longer than, the arm, of an obviously different texture from the branches, and displaying in many cases through its transparent skin the pulsations of the heart, for which we were particularly searching?"

It is also important to notice that certain usually protectively-coloured insects select certain circumscribed situations on trees, while many birds habitually seek their prey on different parts of a tree; and with regard to arboreal animals, it is certainly striking that green is not so universal among these as tawny among those which dwell among sand.

The heading "Protection often due to multiplicity of surrounding objects" is distinctly suggestive, attention being drawn to the difficulty of finding an object on a carpet of complicated pattern, as all know who have hunted the almost proverbially evasive shirt-stud. Elsewhere Mr. Beddard states that he has seen twenty people pass so conspicuous an insect as the common Tiger Moth. The chapter on warning coloration contains records of some new and interesting experiments, which certainly do not always bear out orthodox views of this subject. Most important, too, is the reference to the uncertainty as to the degree of perception of form by insects. The extraordinary indifference to enemies displayed by these animals must have struck everyone who has watched them, and is, perhaps, attributable to their small opportunities of acquiring experience. In speaking of Protective Mimicry, Mr. Beddard suggests that it possibly originated between forms much alike to start with, and the striking resemblances frequently observable where mimicry can hardly be possible would tend to confirm this view. Neither does mimicry appear to be always deceptive, it certainly is not so to the average collector.

There is an interesting closing chapter on Sexual Coloration, and a sentence in it with reference to the work of sexual selection in settling this, is at once characteristic and important. "The question, however, cannot either stand or fall upon its probability or improbability. Actual observation can alone settle the matter."

This may well be taken as the keynote of the book, which is thus of a type eminently desirable in days when theory so far outruns observation, which, like the patient goddesses of Homeric story, has such hard work to do in repairing the breaches left by a rapid predecessor. It remains to be said that the book is in typographical and illustrative execution most attractive, while the coloured plates may well make us wonder "how they do it at the price."

Essay on Life and Death. [Essai sur la Vie et la Mort.] Bibliotheque Evolutioniste, vol. iv. By Armand Sabatier, Professor of the Faculty of Sciences at Montpellier. Paris: Ve. Babé et Cie., 1892.

This volume owes its existence to an attempt on the part of the Professors of Montpellier to bring themselves into closer relations with their city. It is based on a series of popular lectures—parallel in many ways to English University Extension lectures—given by Professor Sabatier to the people of his university town.

The book reveals its origin in many excellent features. It is clear, orderly, historical. The problems are stated in striking ways; the expositions of current views, and of any modifications of them, are simple and direct.

The first and smaller half of the book is on life. It is a detailed comparison between the so-called "organic" and "inorganic." The general point of view is summed up by the author:—"La matière dite brute est vivante. La vie de la matière brute et la vie de la matière vivante sont deux aspects, deux moments différents de la vie. La vie est partout, l'esprit est partout." "So-called inorganic matter is living. The life of inorganic matter and the life of organic matter are two faces of life, two kinds of its energy. Life is everywhere; mind is everywhere." It is an exact and careful attempt to prove and illustrate a theory closely resembling W. K. Clifford's double-faced unity. Most of the barriers between organic and inorganic substances have now been broken down. Substance after substance naturally formed by animals or plants have been built up in the laboratories of chemists. Sensitiveness, movement, growth, individuality, are all questions of degree, and are not the exclusive privilege of living matter. Professor Sabatier makes a detailed examination of the phenomena of life, and finds strict parallels for them all in inorganic substances. The second and larger part of the book is devoted to death; for the author, although he has minimised the differences between living and dead matter, by no means assumes that he has removed the sting from death.

He gives a careful and exceedingly useful account of the contributions to the question of all the most important writers, and makes very pretty critical play among their theories. His own theory is elaborately and somewhat discursively treated. Shortly, it seems to be this: Primitive, unspecialised protoplasm is immortal—at least potentially. So long as conditions are favourable, it would continue to feed, grow, and reproduce. But protoplasm has not remained primitive. Even in the Protozoa it has become specialised, and in the tissues of higher animals becomes increasingly specialised. One result of this is that the power of reproduction becomes limited, and death finally appears. In the Protozoa it may be periodically staved off by conjugation. In the Metazoa certain tissues—notably epithelia—retain for a time the embryonic facility of reproduction and for a time are able to repair the organism. In connection with such tissues the germinal cells arise, and thus reproduction of the whole animal is closely connected with reparation of its parts. But the germinal cells having been formed, the germinal tissues, like all other tissues, ultimately become senescent. Death is the price of specialisation, the penalty paid for progress.

So far, there is nothing very novel or suggestive in Professor Sabatier's book. If there were nothing more, it might be left as an admirable and able review of the subjects by a learned biologist. I have purposely left for separate treatment what seems his most important idea, an idea which has no doubt occurred to most biologists, but which certainly never before has received so striking and suggestive consideration.

It has long been held that the most peculiar feature of protoplasm, the very abstraction of life, is its production only in the presence of already formed protoplasm. *Omne vivum e vivo*: there may be in a flask or a ditch all the constituents of protoplasm, but even under the most suitable conditions these constituents do not come together

unless there is already present a speck of living matter. Professor Sabatier calls this power, by which a cell converts into protoplasm substances which are not protoplasm, "*amorce*"—the power of inducing combination. It is this that is possessed in full force by primitive protoplasm, and so confers on it conditional immortality. It is this that gives embryonic tissues their reparative and reproductive powers. But as cells become more and more specialised they gradually lose "*amorce*," and ultimately die.

But Professor Sabatier collects many instances to show that this—the apparently peculiar feature of life—is really shared with inorganic chemical reactions. Again and again it happens that all the conditions for the production of an inorganic substance may be present, but the reaction will not take place, or takes place only slowly and with difficulty, unless a small fragment of the desired compound be placed in the mixture. It is in the working out of this idea that the most valuable part of the book consists, and it seems, without question, that this line of research will carry biologists almost into the confines of physical chemistry. The outposts from the two sides already see each other. P. C. M.

Horn Measurements and Weights of the Great Game of the World. By Rowland Ward, F.Z.S. Square 8vo. Pp. viii. and 264, illustrated. London: Published by the Author, 1892. Price £1 10s.

In this handsome and well-illustrated square 8vo volume, Mr. Rowland Ward treats of a subject which forms a kind of border-land between sport and science; and the author has thus done well in stating on the title-page that his work is intended as a record for both sportsmen and naturalists. With the mere ambition of the sportsman to beat his rival by obtaining the finest pair of horns or antlers of any species of "large game" on record, the true zoologist has, of course, no sympathy; but, on the other hand, every student of mammals must be interested in learning the maximum development which these appendages are capable of attaining, and from this point of view he thus is clearly indebted to the rivalry among sportsmen.

As its title implies, the greater part of the work is devoted to the Pecora, among which the Bovidæ, from their numerical superiority, claim by far the larger share of space. The horns of the various species of Rhinoceroses likewise come within the scope of the title of the volume. When we find, however, that the dimensions attained by the tusks of elephants, hippopotami, and wild boars, as well as the bodily measurements of lions and tigers, are also given, we feel that the author has scarcely done himself justice in selecting a sufficiently comprehensive title for his work.

The especial value of Mr. Rowland Ward's volume is that it covers a practically new field, there being, so far as we are aware, no other which treats of the whole subject: such records of measurements which exist being, as a rule, scattered through various zoological and sporting works, the publications of zoological and natural history societies, and the columns of sporting newspapers. In the main, the work consists of a series of tables of measurements arranged under the headings of the various species recorded; but in the case of some of the less known or recently discovered forms, more or less detailed descriptions of the animals themselves are given. The tables, in most cases, comprise measurements of a very large

number of specimens, so that the naturalist will be able not only to learn the maximum dimensions of the horns or antlers of the various species, but likewise their average size. Wherever it has been practicable to do so, the locality whence each specimen was obtained, as well as its present ownership, is also recorded. The illustrations, many of which have been specially executed for the work, are in the main good, and render the volume much more attractive than it would otherwise have been.

In most cases Mr. Rowland Ward is well up to date in regard to scientific nomenclature, though he has unfortunately retained a few names which have long ago been consigned to the oblivion of synonyms; and he might, we think, in regard to Indian mammals, have been better advised had he followed Mr. Blanford's recently completed monograph of that subject. Among the figures we notice that the one given on page 239 as that of the head of the common African Rhinoceros (*R. bicornis*), is really one of Burchell's Rhinoceros (*R. simus*); clearly showing (although not altogether satisfactory) the truncated upper lip, long nasal orifice, and tall tubular ears of the latter. In the table of measurements given on the same page we also notice that the second longest Rhinoceros horn known (54 inches) is put down as belonging to *R. bicornis*; whereas, on turning to page 194 of Mr. Selous' "Hunter's Wanderings in Africa," we find that it really pertained to *R. simus*. Indeed, no known horn of the former comes anywhere near these dimensions. We have also observed certain inaccuracies with regard to distribution, which would have been better avoided.

Much as we may regret them as tending to mislead the non-scientific sportsmen, these little inaccuracies scarcely, however, detract from the zoological value of the work, as those versed in the study of mammals will detect most of them without great difficulty.

Since the amount of labour involved in taking the various measurements, most of which were made by the author himself, must have been enormous, Mr. Rowland Ward is to be congratulated on the energy and perseverance which have enabled him to complete his arduous task, and thus to produce a book which, while invaluable to the sportsman, is at the same time of the highest importance to the working zoologist. R. L.

The Sportsman in South Africa. By J. A. Nicolls and W. Eglington. 8vo. Pp. vi. and 147. Plates. London: The British and Colonial Publications Co., 1892. Price, 10s.

The stream of works on South African animals and sport seems endless, but the one before us is decidedly above the average, and is worthy to rank alongside Mr. Selous' well-known volume. It is stated on the title page that the object of this work is to describe the haunts, habits, form, and pursuit of all the so-called game animals—both mammalian and avian—which are to be found in the country lying to the southward of the Zambesi; and, so far as we can judge, this task has been carried out very creditably. The most striking feature of the book is the excellence of the illustrations, which comprise upwards of 68 figures, contained in twelve plates. The figures are executed by some process with which we are unfamiliar, but which, from an artistic point of view, is deserving of the highest praise, and is far above the level of the ordinary woodcut. This artistic excellence is, moreover, obtained without any loss of fidelity to nature; and some

of the illustrations, like the one of the head of the Eland (which we owe to the courtesy of the publishers) are the most spirited and at the same time the most faithful likenesses of the animals they portray that we have come across for a long time.

The work commences with a chapter on the equipment necessary for a sporting trip in South Africa, which is followed by others relating to the fearful destruction of game which has there taken place, and the efforts which have been made to preserve the small remnant ere it is too late. The authors state that, apart from the question whether such enactments as were made were ineffectual in themselves, or were too late in their appearance, there is no doubt

Head of Eland (*Oreas canna*).

"that, with the exception of a few wild elephants, and, perhaps, buffalo, which still eke out a harried existence, although protected in the Colonial Government's forests, and also an odd troop of zebras, koodoos, and probably hartebeest, which serve as ornaments in a semi-domesticated condition on some of the out-of-the-way farms, the remnant of the noble game which once roamed in countless thousands all over the country, for which Southern Africa was pre-eminently renowned, has been, by wanton and ruthless slaughter, decimated or driven far beyond the outermost bounds of civilisation into the pathless veldt of the Kalahari, or the inhospitable territories of the aborigines of the Interior." While participating in the authors' regrets, the naturalist cannot but rejoice that there are still such

havens where the remnants of many of the species can find a refuge, instead of sharing the fate which there is only too much reason to fear has befallen the Quagga and Burchell's Rhinoceros.

In the descriptive part of the work each species referred to has a brief diagnosis, followed by a notice of its habits, and its present distribution; the latter being especially valuable to the zoologist. Perhaps the most interesting passage in the volume relates to the pair of horns on the evidence of which Dr. Günther gave the name *Antilope triangularis*; the supposed new animal being subsequently raised to generic rank under the title of *Doratoceros*. The authors of this volume are, however, of opinion that these horns are really nothing more than abnormal examples of those of a Kudu. From a specimen that has recently been brought to our notice, we are, however, inclined to endorse the view of a recent writer in the *Field*, that they belong to a Cow Eland.

This work ought to be useful to the naturalist in general, and of especial value to all those interested in the natural history and sport of South Africa, to whose attention it may be cordially recommended. R. L.

A Vertebrate Fauna of Lakeland, including Cumberland and Westmoreland, with Lancashire North of the Sands. By Rev. H. A. Macpherson, M.A., with a Preface by R. S. Ferguson, F.S.A. Pp. 650, with 6 etchings, 2 coloured plates, map, and woodcuts. Edinburgh: David Douglas, 1892. Price, £1 10s.

Chancellor Ferguson prefaces this bulky work with a lucid and terse description of the chief physical features of the English Lake District. The Prolegomena include essays on a variety of subjects, and are illustrated by some fine woodcuts, drawn by Miss E. C. Woodward. The author acknowledges in the Prolegomena his obligations to Mr. R. Lydekker, who favoured him with assistance in determining some animal remains from the cave-deposits. The mass of the book deals with the present vertebrate fauna of this fascinating region.

The author, being interested in ornithology as a specialist, the second book, dealing with Aves, is naturally the fullest, and describes at great length the habits of wild Swans, of Sand Grouse, and many other species of birds, combining all available historical information with the results of ten years' work at field ornithology. Of the other books, the first contains really important articles on the Pine Marten and the Red Deer. The fourth book, which deals with the fishes, is full of antiquarian lore. The chief local names of animals are supplied in a glossary. Six full-page etchings of local scenery, and two coloured plates of birds lately added to the British list, accompany the text, which is further explained by a carefully drawn map, showing the various elevations in different colours. Both author and publisher are to be congratulated on having produced a most useful and artistic compendium.

The Birds of Devon. By W. S. M. D'Urban, F.L.S., F.E.S., and Rev. M. A. Mathew, M.A., F.L.S., M.B.O.U. Pp. lxxxvii., 459. Illustrated with maps, photos, and coloured plates. London: R. H. Porter, 1892. Price, 21s.

The south-west peninsula of England possesses an avifauna only second in interest to that of Norfolk, and has been the scene of much valuable field work during the last half century. The present volume

not only summarises the long labours of the authors, both of whom are veteran ornithologists whose names carry weight, but it further supplies reference to almost all the rarest birds that have ever straggled to Dorset, Somerset, Devon, and Cornwall. The text is massive and full of detail. We should, however, have been glad if the authors had excised certain portions of their book, such as the long and somewhat superfluous dissertations on the families of birds, which occupy space and tend to obscure much more interesting details. The authors also do not always succeed in bringing the most important facts at their disposal into prominence.

Mr. Murray Mathew is one of the few professed ornithologists who have seen Sabine's Gull alive on the coast of Britain; but he relates his experiences thereon with such excessive modesty, and such an absence of feeling, that one would imagine he felt no emotion at all in such a remarkable position. Other instances in which the writers have failed to do justice to their own researches could easily be cited; but the work, taken as a whole, is an admirable monument to the patient and protracted labours of two English gentlemen, who study birds as born naturalists, and not as collectors.

Not the least attractive feature of this fine volume is furnished by four beautiful plates from the brush of that skilled artist, Mr. Keulemans, representing the Black Redstart, Montagu's Harrier (black variety), Rough-legged Buzzard (black variety), and Great Black-headed Gull.

The frontispiece is a sketch of "Yes Tor," the home of the Ring Ouzel, executed by the late W. H. M. D'Urban. The volume is tastefully bound, printed in good type, and supplied with a useful working index. We trust that it will find a place in the library of every British ornithologist.

The Birds of Lancashire. By F. S. Mitchell, Member of the British Ornithologists' Union. Second edition. Revised and edited by Howard Saunders, F.L.S., F.Z.S. With additions by R. J. Howard, M.B.O.U., and other local Authorities. 8vo. Pp. xxvi., 271. London: Gurney and Jackson, 1892. Price, 10s. 6d.

The second edition of this excellent county fauna will be heartily welcomed by ornithologists. It is true we should have preferred that the author himself should bring the text up to date, but, in his absence, this task has been admirably performed by Mr. Howard Saunders.

The editor has left the text almost untouched, with the exception of some literary blemishes, which he has taken great pains to remove. He has, however, added numerous notes in brackets, many of them supplied by a most competent local naturalist, Mr. R. J. Howard, of Blackburn, who undoubtedly knows the avifauna of his county extremely well. It is pleasant to read such notes as those which Mr. Howard has contributed on hybrid Pochards (*see* p. 173); or upon the Grey Geese which frequent the marshes of the Ribble estuary. Mr. Mitchell's list of the birds of the county is now supplemented by five additional species—the Purple Heron, Sociable Plover, Eared Grebe, Wilson's Petrel, and Frigate Petrel; the last of these has just been figured as a new bird to Britain in Macpherson's "Fauna of Lakeland," the proof-sheets of which were placed at Mr. Saunders' disposal.

The great merit of this book consists in the fact that ornithologists can see at a glance the salient points about almost every species

under consideration. A serious defect is the scanty information supplied about some few species. For example, all that we are told about the Red-necked Phalarope is this: "A rare visitor on passage; it is said to have been shot on the Ribble." We only mention this, however, as a clear proof that there is still work to be accomplished by Lancashire ornithologists in mapping out the visits they receive from some of their rarer species. We hope that the appearance of this admirable edition, with its improved index, will spur them on to renewed exertion. The coloured plates of the Wall Creeper and Black-throated Wheatear, which accompanied the first edition, are now replaced by two of the choicest of Mr. G. E. Lodge's woodcuts. We regret that the Wall Creeper obtained in Lancashire, the only British specimen extant, was fated to pass into a private collection, when Mr. Mitchell left England. It should certainly have been secured for the national collection.

The Conchological Society's List of British Land and Freshwater Mollusca, 1892. Compiled by W. Nelson, W. Denison Roebuck, F.L.S., and J. W. Taylor, F.L.S.

Such a list as this comes eminently within the province of a body like the "Conchological Society of Great Britain and Ireland," and the present new edition should have been made thoroughly complete and reliable that it might serve as a guide for the multitude of votaries of the Science, youthful and otherwise, whom we are glad to think abound over the country.

Numerous changes and some improvements have been introduced into the present issue. The old artificial division into Land and Freshwater forms has been abandoned in favour of a more scientific classification, which, however, is capable of yet further emendation as regards the slugs. The Arionidæ, which head the list, should come nearer the Helicidæ, and their place be taken by the Testacellidæ.

The nomenclature has been revised, and several changes made in conformity with the inexorable law of priority. *Helix sericea*, Müll., becomes *H. granulata*, Ald.; *H. ericetorum*, Müll., is now admitted to be Linné's *H. itala*, as long ago shown by Hanley. Whether the *Planorbis marginatus*, Drap., is Müller's *P. umbilicatus*, as now advanced, is very questionable. The genus *Bulimus* disappears: *B. acutus* being rightly transferred to *Helix*, and the other two British species referred to *Buliminus*. *Cyclostoma*, on the other hand, we are glad to see, is retained. The genera *Amphipeplea*, *Segmentina* and *Velletia* are revived for their appropriate species of Limnæidæ; but this being so, it would have been more consistent had *Patula* likewise been allowed to stand as a genus. *Paludina* gives place to *Viviparus*: surely the feminine form would have been more appropriate. *Anodonta anatina* still masquerades as a species, despite the fact that even Isaac Lea would have none of it. *Testacella scutulum*, Sow., is re-established, although further confirmation of its specific distinctness is really desirable. The sectional names of *Trichia* and *Zenobia* have by some oversight been omitted under *Helix*, with the result that the *Fruticola* group is unduly rich in species.

Synonyms are only given where a well-known name has had to give way to an earlier and comparatively unknown one, which they follow in each case in parentheses. Here a confusion arises, owing to the way in which these are expressed. Thus we find "(=*L. margina-*

tus, Jeffr.)" and "(=*H. concinna*, Jeffreys)"; the latter is correct, since it was Jeffreys' own species, but the former is misleading, inasmuch as Jeffreys did not describe any such species. He held (and we believe quite correctly) that the *Limax sowerbyi*, Fér., was a synonym of *L. marginatus* Müll., and accordingly adopted the last name. This could have been made quite clear by putting "(=*L. marginatus*, Müll. of Jeffr.)."

It should also be pointed out that *Cochlicopa*, Fér., was a mixture of very distinct forms, and to Risso belongs the credit of first defining it accurately; hence it is *Cochlicopa*, Risso, or cannot stand at all. There are other small errors in the authorities quoted for specific names, such as *Hyalinia glabra*, attributed to Studer, who, we believe, never described it, while Müller is throughout quoted as Mull., instead of Müll. The compilers also persist in identifying *Planorbis glaber*, Jeff., with the American form *P. parvus*, Say, although the distinctness of the two has been pointed out (*Proc. Geol. Assoc.*, vol. xi., p. 381).

The most objectionable feature of the list, however, is the wholesale introduction of the so-called varietal names. It is true that these trashy designations (which in most cases are applied to mere variations and not to varieties in the strict zoological sense of the term) are not so abundant as in a certain other list recently published, where the array of names appended as "vars." to each species sometimes leads off with "typicus" or "typus"; all the same, they are, scientifically speaking, worthless save in instances, rare, indeed, in this limited area, of forms well marked zoologically or geographically. It is sad to think what an amount of time is wasted in the attempt to identify these delusive "vars." that might be spent in the accomplishment of work of real scientific value. Alas that the variety-monger should be as blind to higher glory as the character depicted by Bunyan intently gathering to himself not overclean straws! The space these varietal names consume might have been turned to account for valuable notes or for synonymy, but this we fear we must wait for till a certain work, long advertised as in preparation, shall appear. Unless, perhaps, since the authors of that work are still struggling with the first genus, *Testacella*, the Conchological Society may meantime arouse itself and vindicate its high-sounding title by appointing a committee of its competent members, who shall produce a correct and reliable list, not of a section merely, but of the whole of the molluscan fauna of these Islands and their surrounding waters. (BV).[2]

Contributions to the Study of the Sponges of the North Atlantic. [Contributions à l'étude des Spongiaires de l'Atlantique Nord.] By E. Topsent. Results of the Scientific Explorations of Albert I., Prince of Monaco. 4to. Pp. 166, pls. xi. Fascicule ii. Monaco: 1892.

In this beautiful monograph of 166 pages and 11 plates are described the sponges collected by the Prince of Monaco, on board the "Hirondelle," in the North Atlantic. The work is almost entirely systematic, but, in an introduction, the author gives a short account of his views on sponge histology—a subject to which he has himself made important contributions in recent years. The whole number of species described amounts to 167, of all orders, of which 58 are new, with 8 new genera. With regard to these new species, we may notice incidentally, for the benefit of that most necessary, but often unappreciated person, the recorder, that though the author writes n. sp. after the species, many of them have already been named

and enumerated by him in preliminary accounts, and will be found recorded in the *Zoological Record* for 1890. Hence, they are not all of them, strictly speaking, new species, though here described for the first time. The nomenclature of spicules published in the "Challenger" Reports is adopted, with the addition of a few names for some new forms of spicules. In classification, the following modifications are proposed:—The order Carnosa, of Carter, is revived, to include the suborders Microsclerophora (Sollas), Oligosilicina (Vosmaer *pars*, *Chondrilla*), and Myxospongida (*Chondrosia* and *Oscarella*). The Monaxonida are classified into Spintharophora (Sollas emend.) and Halichondrina. The latter name is used in the same sense as by Ridley and Dendy in the "Challenger" Reports (vol. xx.). The Spintharophora are divided into Aciculida, with diactinal spicules (Epallacidæ, Stylocordyla, and Tethyadæ), and Clavulida with monactinal spicules (Spirastrellidæ, Suberitidæ, and Clionidæ). The monograph is got up in splendid style, and well printed, and the illustrations are excellent. We may specially draw attention to plate i., containing beautiful coloured pictures of living sponges depicted on board the yacht. M. Topsent must certainly be congratulated on having given us a valuable contribution to the study of an interesting group. E. A. M.

THE FUTURE OF SILVER. [Die Zukunft des Silbers.] By Professor Edward Suess, 8vo. Pp. iv. and 227. Vienna and Leipzig: 1892.

THE Silver Question in general, and the theory of Bimetallism in particular, in the main lie outside the scope of NATURAL SCIENCE; both, however, ultimately depend on the relative abundance of the supply of gold and silver, and this is a purely geological question. We cannot, therefore, follow Professor Suess into the interesting questions of economics and currency raised in his latest work, but as the main part of the volume is devoted to a sketch of the present condition and future prospects of the gold and silver mining fields, of the mode of occurrence of the ores, and of the factors which govern the possibility of their profitable exploitation, the book cannot be allowed to pass unnoticed. Professor Suess, the Professor of Geology in the University of Vienna, is one of the foremost of living geologists, and his "Antlitz der Erde" inspired two of the Presidential Addresses at the last meeting of the British Association; he has special qualifications for the treatment of this subject, being equally eminent as an economist, and his work "Die Zukunft des Goldes," which appeared in 1877, has taken high rank in the literature of the Silver Question. To this, the present volume is a sequel, written to trace the history of the production of gold and silver during the past fifteen years, and to show that the predictions then made have been verified by subsequent events. The book is divided into ten chapters, of which the first five deal with the questions of the occurrence and supply of gold and silver, and the last five with the economic consequences that result therefrom.

In the introductory chapter Professor Suess deals briefly with the Californian and Australian gold discoveries of 1849, and with the visions that these encouraged of a universal international gold currency. These hopes were, however, strongly discouraged by the geologists of the time, and quotations are made from a paper by Murchison in 1854 warning politicians that the enormous gold supply of that period was quite temporary. In the second chapter the author summarises the history of the variations in the gold supply since 1877, and points out that

gold occurs in three ways: as sulphides in deep veins, as metallic gold in superficial "gossans" that result from the weathering of veins, and as alluvial gold. Statistics are quoted of the recent productions of the Californian, Dakotan, Australian, Russian, Siberian, and South African mines; in a later chapter the figures are also added of the Chinese, Indian, and South American workings. The general results show a steady decrease in the proportion yielded by the alluvial deposits: thus from 1848-1875 these yielded 87·7 per cent., in 1876, 65 per cent., and in 1890 only 44·2 per cent. In the face of the difficulties in the working of the deep sulphide deposits, Professor Suess concludes that we shall always be practically dependent for gold for currency on the alluvial workings; mine after mine has been closed as soon as the gossan was removed and the sulphide vein reached. Nor does Professor Suess regard the Transvaal conglomerates as a durable source of supply. During the last few years the total gold supply has declined but slightly, and last year has witnessed an actual increase; but this is shown to be due to the extraordinary efforts of the miners with such tremendous works as the Amador mining canal, 100 miles in length, and the draining of the Feather River by the Big Bend Tunnel nearly three miles long. On pages 98-102 the author has collected the statistics of the amount of gold used in the arts, and concludes that it is now closely equal or slightly in excess of the annual supply. The recent history of silver production is similarly treated and the enormous increase in the output shown. One of the most interesting chapters in the volume is that which records the tragic history of the Comstock lode, from its discovery in 1857 to its final abandonment in 1891. The mines were worked first for gold and then for silver, and the greatest yield for any one year was 37,000,000 dollars in 1876. The story of the mine as Professor Suess tells it us is a singularly varied one: the early settlers were rough even for the Western States, and from murder, famine, and sudden death the romantic records of this lode have not been delivered.

The first part of the volume shows the approaching exhaustion of gold, and the apparently limitless nature of the supply of silver. The ratios of the production of the two were—1 : 5·47 in 1860, 1 : 14 in 1880, and 1 : 23·8 in 1890; the value ratios have consequently gradually changed till they stand at 1 : 22·10 and not 1 : 15·5, which the older schools of bimetallists declared would be permanent. There is too little gold and too much silver, and with the contraction of the gold currency serious commercial difficulties have arisen; prices have fallen, bank reserves have only been maintained at the cost of frequent changes in the bank rate; and, as Professor Suess remarks, any alteration in this immediately affects prices all the world over. Industrial crises have resulted, and it is maintained that they are inevitable until some means be discovered of increasing the medium of exchange. Professor Suess is not a bimetallist, and probably the most valuable part of his book is that in which he emphatically protests that any hope of fixing a definite ratio between gold and silver is quite vain. "This divergence [that between their relative values] lies in the nature of the metals themselves," he tells us on p. 193, "and no statesman and no law can alter their natural relations." Professor Suess, therefore, predicts that the time is coming when silver will be used as the medium of the world's currency. This is not a solution that English financiers are likely to welcome; but while they remain as hopelessly divided as they are at present, it is difficult to conclude whether the truth lies more with the advocates of bimetallism or the champions of the opposite school.

GEOLOGICAL MAP OF SCOTLAND. By Sir Archibald Geikie, D.Sc., LL.D., F.R.S., Director-General of the Geological Survey. Edinburgh: John Bartholomew and Co., 1892. Price 6s.

STUDENTS of British Geology and travellers interested in the relations between scenery and rock-structure, will welcome this new Geological Map of Scotland; for the scale is sufficiently large to show the distribution of the principal groups of rocks, and the topography is based on the latest Ordnance Survey. Moreover, the map is well printed, and the colours, numerous as they are, clearly show the various subdivisions of the rocks.

It was thirty-one years ago when the "First Sketch of a New Geological Map of Scotland, with Explanatory Notes," was issued by Sir Roderick Murchison and Archibald Geikie; and this map was on a scale of 25 miles to an inch. It summarised our knowledge at that date, recording work done by Macculloch, Nicol, Harkness, and others, and that done in a portion of the south of Scotland by the Geological Survey. Much original work was likewise incorporated, for Skye and Raasay, and parts of Islay and Jura, and the Highlands, had been personally surveyed by A. Geikie; while Sutherland and Caithness, the Shetland and Orkney islands, and other parts were coloured according to the work of Murchison. A larger Geological Map of Scotland, by A. Geikie, was published in 1876.

Now, the Geological Survey has mapped in detail the southern half of Scotland, and a large part of the central and north-western Highlands, while Professor Lapworth, Professor Judd, and others, have contributed largely to our knowledge of particular strata, so that it is appropriate that a new and larger map should picture the progress that has been made. This map is accompanied by Explanatory Notes (pp. 23), in which is given a concise account of the leading features in Scottish Geology.

In the older map two colours were used to denote Laurentian and Cambrian rocks. Now the Pre-cambrian rocks are taken (in the Explanatory Notes) to include Lewisian, Dalradian, and Torridonian; and no less than 10 coloured tablets serve to indicate divisions that can be made in the Metamorphic rocks of the Highlands (grouped as Dalradian), and two tablets include other divisions of Serpentine and Lewisian Gneiss. The relations of the "Eastern or younger Schists" (to which the name Dalradian has been applied by Sir A. Geikie) are still so obscure that they cannot be placed in a definite position in the stratigraphical series. The Torridon Sandstone, now known to be Pre-cambrian, is followed unconformably by the Cambrian strata; and these again can nowhere be traced in sequence with the Silurian rocks, of which the lowest portion is correlated with the Arenig group. Succeeding strata of Old Red Sandstone, Carboniferous, Permian, Triassic, Jurassic, and Cretaceous are duly indicated; there being 19 coloured tablets to represent the main divisions from the Torridon Sandstone to the top of the Mesozoic strata. Four other tablets serve to indicate the Tertiary and Post-tertiary deposits, and eight tablets are given to various Igneous rocks.

The scale of the map is 10 miles to an inch, so that in size it is a little over 2 ft. wide by 2 ft. 6 in. in length; and it should be mentioned that the Orkney and Shetland Isles, and also the adjoining tracts of Cumberland and Northumberland, and a small part of the north-east of Ireland, are coloured geologically. There are likewise seven longitudinal sections. Altogether, the map is an excellent one, and the modest price of six shillings will ensure for it a wide circulation.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

Under the will of the late Mr. Hodgkin, of Long Island, the Royal Institution of Great Britain benefits to the extent of £20,000.

Mr. Walter E. Collinge has been appointed Demonstrator in Biology in the Mason College, Birmingham, and Mr. W. G. Ridewood, B.Sc., has been elected to the new Lectureship in Biology in St. Mary's Hospital Medical School, London

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Dr. B. L. Robinson has been appointed Curator of the Herbarium of Harvard University, Cambridge, U.S.A., in succession to the late Dr. Sereno Watson. Dr. Robinson has hitherto occupied the position of Assistant Curator. According to the *Botanical Gazette* arrangements have been made by which he will be enabled to devote some time to the completion of the "Synoptical Flora," as it is intended to proceed with this great work as rapidly as possible.

We learn that Messrs. Iddings and Penrose have accepted appointments on the staff of the new Chicago University under Professor Chamberlin. The former will lecture on Petrology and Mineralogy. Dr. Walcott has been offered the position of Palæontologist in the same University. It is now arranged that the Academic year shall be divided into four quarters, each of two terms, and that no student shall be required to attend more than six terms each year.

Lord Walsingham, High Steward of Cambridge University, has arranged to present a gold medal annually for a period of three years to the member of the University who shall send in to the Board for Biological and Geological Studies the best original monograph on some department of Natural History research. The date fixed for the first competition is October 1, 1893.

Professor Claus has issued the first part of vol. x. of the *Arbeiten aus dem Zoologischen Institute der Universität Wien und der Zoologischen Station in Triest*. The Professor contributes the second part of his memoir on the development of the Scyphomedusæ, concluding with a discussion of their systematic relationships. Dr. B. Haller describes the anatomy of a gastropod mollusc, *Siphonaria gigas*, which he believes to be one of the most primitive known types of Opisthobranchiata, peculiarly modified by its surroundings. Each memoir is illustrated by three plates.

We are glad to announce that the condition of Sir Richard Owen has considerably improved, and except for the resulting loss of strength his health, according to Sir James Paget, is as good as it was before the last attack. Sir Richard Owen derived considerable pleasure from a visit of the Prince of Wales, who with characteristic kindness called on Sunday, the 11th, with the Duke of Teck and the Princess May. Sir Richard Owen is now in his 89th year, and were it not

for weakness in the limbs and the fear of cold, might be able to dress daily and sit in the library adjoining his bedroom. His great deafness, however, prevents him from seeing others than his intimate friends.

Mr. Charles Andrews, B.A., B.Sc., is the successful candidate in the recent examination for the position of Assistant in the Geological Department of the British Museum. As soon as the subsequent formalities have been completed, he will commence work on the fossil Vertebrata.

The Botanical Department of the British Museum has lately benefited by the acquisition of two cryptogamic collections of great value The one is the large herbarium of the late Mr. George Davies, of Brighton, and consists of some 20,000 specimens. It was presented by his widow. The deceased gentleman devoted more than thirty years of his life to a keen study of the mosses, hepatics and lichens, which he partly himself gathered in the British Isles and the south of Europe, and partly received from correspondents in distant parts of the world. The other acquisition is a very complete set of 494 Hepatics, collected by the distinguished traveller and botanist, Dr. Richard Spruce, in the River Amazon and the Andes of South America, during the years 1849-60, and ably monographed by his masterly hand in the *Transactions and Proceedings of the Botanical Society of Edinburgh*, vol. xv. (1885).

The second part of Mr. George Murray's *Phycological Memoirs*, embodying the results of researches on Algæ conducted in the Botanical Department of the British Museum, is nearly ready for issue. Besides papers on the West Indian Algæ and a comparison of the marine floras of the warm Atlantic and Indian Ocean by the Editor, there will also be notes on the Fucaceæ by Miss A. L. Smith, Miss Barton, and Miss F. G. Whitting.

The Smithsonian Institution has lately issued vol. xxviii. of its "Contributions to Knowledge," an elaborate work entitled "Life Histories of North American Birds, with special reference to their Breeding Habits and Eggs," by Captain Charles Bendire, Hon. Curator of the Department of Oology in the U.S. National Museum. The volume deals only with land-birds, and is illustrated by twelve fine coloured plates of eggs. It is based on the author's field notes and the collection in the U.S. National Museum, and there is a reference to every published observation of importance in regard to the habits and distribution of each species.

The Curator of the Kingston Museum, Mr. T. D. A. Cockerell, is displaying praiseworthy activity in his new sphere, and contributes to the current number of the *Journal of the Institute of Jamaica* (vol. i., no. 4) a series of original notes on the local Mollusca, Insects, Myriapods, and Fungi, several in co-operation with well-known specialists. Some new genera and species of insects are described, but without figures. The description and a quaint picture of the earthquake at Port Royal on June 7, 1692, are reprinted from the originals in the British Museum and form an interesting contribution to the Journal. The Institute is evidently doing good work in the promotion of scientific studies in Jamaica.

Two new parts of the *Records of the Australian Museum* (vol. ii., nos. 2, 3) were issued in August. Professor Liversidge contributes the first paper on some bismuth minerals, illustrated by three plates. Mr. A. G. North records some additions to the known Avifauna of Tasmania and Norfolk and Lord Howe Islands, and also has a note on the nesting of the Manucode (*Manucodus comrii*) with figures of the eggs. Mr. J. Douglas Ogilby describes some new reptiles and fishes from Australia, and Mr. C. Hedley discusses the structure and affinities of a land snail, *Panda atomata*, with several illustrations.

THE movement for the Sunday opening of Museums still progresses in England. The Town Council of Sunderland has just resolved to open the Public Museum and Art Gallery each Sunday afternoon from two until six o'clock, while the Reference Library will be open from six until nine in the evening. It is estimated that the additional expenditure incurred will not exceed £60 per annum.

PROFESSOR JAMES GEIKIE'S Address to the Geographical Section of the British Association at Edinburgh (1892) is printed in the *Scottish Geographical Magazine* for September, and is accompanied by a Bathy-hypsometrical Map of the World, coloured to show the surface-relief of the globe without water in the Ocean Basins.

AT the recent meeting of the American Association at Rochester, New York, a resolution was passed in favour of the scheme for a series of International Scientific Congresses to be held next year at the Chicago Exhibition. Committees were appointed to co-operate with the local organisations in making arrangements, and it is expected that reports of the proceedings will be published.

A BRIEF report of the recent International Zoological Congress at Moscow is contributed by Baron Jules de Guerne to the *Revue Scientifique* of October 8. Count Kapnist presided, and there were eleven general meetings, extending over a period of nine days. The French naturalists were represented by Drs. Milne-Edwards, R. Blanchard, and C. Schlumberger, with Baron de Guerne and a deputy for the Prince of Monaco; and among other foreign zoologists present were Professor Virchow and Dr. H. Virchow, of Berlin, Dr. Brusina, of Agram, Dr. Th. Studer, of Berne, and Dr. Jentink, of Leyden. Britain seems to have been unrepresented. Among the subjects discussed were the Northern Asiatic fauna, the Black Sea and Baltic Sea faunas, the classification of the variations of animals according to their causes, the arrangement of the Animal Kingdom in phyla, the value of embryology in classification, the scientific aspects of zoological gardens, and zoological nomenclature. The discussion of the latter subject occupied two ordinary meetings, and was continued from the Paris Congress. The Czar and Czarewitch contributed to the funds of the Congress, and the Grand Duke Sergius Alexandrowitch, Governor of Moscow, personally attended some of the assemblies. The next Congress will be held at Leyden in 1895, Dr. Jentink being president-elect.

THE rules of zoological nomenclature adopted by the Moscow Congress are also published in the same number of the *Revue Scientifique*. The more striking articles are as follows:—

1. The tenth edition of Linnæus' *Systema Naturæ* (1758) to be recognised as the basis of zoological nomenclature.

2. The law of priority to be applicable to the names of families and higher groups exactly as in the case of generic and specific names.

3. The law of priority to prevail, and thus the oldest name to be retained even when given to an identifiable fragment of an extinct animal or to the larva of a living animal.

4 A generic or specific name once published cannot be rejected, even by its author, on account of inapplicability.

5. Hybrid names not to be altered.

6. Capital initials to be employed in all specific names derived from proper names, and the original orthography to be preserved, even retaining accents.

7. When a species is removed from one genus to another, the name of the original author of the specific name to be placed in parentheses, thus:—*Ponto della muricata* (Linn).

8. The name of a family to be changed when the name of the type-genus of the family proves to be a synonym and disappears from nomenclature.

9. Every generic name preoccupied in the same kingdom (règne) to be rejected.

On October 5 a number of members of the British Ornithologists' Union dined together and formed a British Ornithologists' Club, which will meet monthly in London from June to October in each year, and issue a monthly Bulletin. The object of the Club is to promote social intercourse between members of the Union, and a small annual subscription will be levied to cover publication and other expenses. The first committee consists of the Earl of Gainsborough, Dr. Sclater (Editor of *The Ibis*), Dr. Bowdler Sharpe (Secretary and Editor of the Bulletin), and Messrs. Bidwell, Seebohm, and Howard Saunders (Treasurer). At the opening meeting, Mr. Edward Degen read a paper on "Some of the Main Features in the Evolution of the Bird's Wing," which will appear *in extenso* in an early number of *The Ibis*.

Colonel Bailey, R.E., Lecturer on Forestry in the University of Edinburgh, has been appointed Secretary of the Royal Scottish Geographical Society, in succession to Mr. Arthur Silva White. At the anniversary dinner of the Society, held in Edinburgh on October 19, under the Presidency of the Marquis of Lorne, Mr. White was presented with a sum of £400 and an honorary diploma of fellowship.

The Société Scientifique de Chile has issued the first part of the second volume of its *Actes*. It comprises one elaborate memoir of 174 pages by Professor F. P. Borne on a Chilian spider, *Latrodectus formidabilis*, and a record of the Proceedings of Meetings. The first Annual Meeting was held on April 4th, when the Society was reported to be in a flourishing condition both as regards membership and finances. The *Actes* are published in bi-monthly parts and freely distributed abroad.

The last (June) part of *Timehri*, the Journal of the Royal Agricultural and Commercial Society of British Guiana, contains among other matter valuable papers by Mr. J. J. Quelch, on the Bats and Birds of Prey of British Guiana, and numerous short notes on the Natural History of the Colony. There is also a brief article by Mr. T. S. Hargreaves on Guiana Gold.

The Woolhope Naturalists' Field Club is somewhat dilatory in its publications, the volume of *Transactions* for the years 1886-89 having only been issued last month. In addition to the ordinary reports of meetings and excursions, the new volume contains many brief but valuable contributions to the Natural History of the Club's district, and there are several plates, illustrating papers on Archæology.

Part VII. (1891-92) of the *Transactions of the Leeds Geological Association* has just appeared. The frontispiece is a photograph of the base of the trunk of a fine Carboniferous tree, found in the Gannister at Meanwood; and the principal contributions to local geology are those of Mr. B. Holgate on Glacial Deposits in Teesdale, and Mr. J. E. Bedford on Glacial Action in the Leeds District. Many general questions of great interest are also briefly treated, and there are the usual reports of excursions.

OBSERVATIONS AND CORRESPONDENCE.

The Permanence of Ocean Basins.

It seems desirable that I should say a few words in reply to Dr. Blanford's letter in the last issue (p. 639), and to Mr. Jukes-Browne's article in the preceding number of Natural Science (pp. 508-513).

Both these writers lay stress upon a supposed considerable modification of my views in my late paper. I reply that there is no real alteration; because the 1,000-fathom line was never adduced by me as an absolute and rigid boundary between the oceanic and continental areas, but as a general indication of their respective limits according to the best obtainable evidence. In proof of this, I may point out that even in the first edition of "Island Life" (p. 444) I refer to a submarine plateau at a depth of between 1,000 and 2,000 fathoms, which stretches southward from New Zealand towards the Antarctic continent, and suggest an ancient connection "with the Great Southern Continent by means of intervening lands and islands"; and in my "Darwinism" (p. 346) I define the permanence of oceanic and continental areas as meaning that, "while all of them have been undergoing changes of outline and extent from age to age, they have yet maintained substantially the same positions, and have never actually changed places with each other"; and again, at p. 347, after stating that the 1,000-fathom line "marks out, approximately, the continental area," I add: "There may, of course, have been some extensions of land beyond this limit, while some areas within it may always have been ocean; but so far as we have any direct evidence, this line may be taken to mark out, approximately, the most probable boundary between the continental areas and the great oceanic basins."

In my recent paper I have merely repeated and enforced these statements by showing how little real difference is made by carrying the possibilities of Continental extension, in rare cases, as far as the 1,500- or 2,000-fathom line. There is, therefore, no ground for alleging any departure from supposed "extreme views" which I formerly held, since the fresh arguments I have adduced show any great extension beyond the 1,000-fathom line to be in the highest degree improbable.

Dr. Blanford objects to my statement that the theory of the permanence of the ocean basins was "attacked" by him. Perhaps the word was not well chosen, and I should have said "criticised," but it was held by Mr. Jukes-Browne to be such a damaging criticism that (in private correspondence) he expressed surprise that I had not replied to its arguments in the new edition of "Island Life." But though the passage quoted by Dr. Blanford is not very antagonistic, there is much in the "Address" itself that is altogether opposed to my views. For instance, the writer argues in favour of a former land-connection between South America and Africa, which he says is "chiefly shown by tropical forms," though adding, "but these may have migrated far southward during warm periods;" and, later on, he speaks of a possible "girdle of land, chiefly in low latitudes, round nearly three-quarters of the globe, from Peru to New Zealand, and the Fiji Islands." But any such land-extension as this is so wholly inconsistent with the permanence of the great ocean basin of the Pacific, that to argue in favour of it is certainly to attack the theory of permanence. Again, a direct land-connection between South Africa, Madagascar, and the Peninsula of India is very strongly advocated, but the 1,000-fathom line shows us an actual though slightly circuitous connection by means of existing continental areas between Africa and India, and to hold that this would have been insufficient—why, I cannot

possibly understand—and to prefer to bridge across an ocean between 2,000 and 3,000 fathoms deep, in order to reduce the distance to about three-quarters of the other route, is again to hold views totally inconsistent with the theory of ocean-permanence.

Even in the passage from his "Address" quoted by Dr. Blanford, there is more antagonism than agreement; for I cannot admit that "there is no evidence whatever . . . that every ocean-bed now more than 1,000 fathoms deep, has always been ocean." If by "every ocean-bed" we mean the great oceanic basins as distinguished from deep seas within continental areas, and if we admit those very rare and limited encroachments of old continents on the margins of these oceans; which, as I have shown, I have always admitted, then I maintain that there is very strong evidence indeed of the permanence of all the great ocean-basins, and that the 1,000-fathom line still gives us the best indication of the general limits of the old continental areas. This is so, because the facts adduced in my last paper show that any extension of the continents into the oceanic areas much beyond the 1,000-fathom line would necessitate the submergence to great depths of many times their area of existing land.

Before concluding, I must briefly notice a very extraordinary claim of Mr. Jukes-Browne. He says ("Evolution of Oceans and Continents," p. 510):—"Those who oppose the doctrine of permanence say that the present continents are the outcome of a long series of geographical mutations," each phase being "an episode in a long process of geographical evolution."

But this is exactly what those who *uphold* permanence have always said. Dana taught the evolution of the American continent nearly forty years ago; Sir Archibald Geikie has discussed "Geographical Evolution" with permanence of continental areas; and I myself, following these great masters, have endeavoured to sketch out the process of this evolution and its results. This "process of evolution" necessarily implies permanence of position of the continental as regards the adjacent oceanic areas—the only permanence that has ever been postulated by myself or others, and it is simply amazing to find this very process now claimed as if it were the discovery and the distinctive teaching of those who oppose permanence!

In conclusion, I may say that, while admitting with pleasure the growing approximation of views on this subject, I cannot forget that it has been, and still is with many writers, the practice to assume former continental extensions across the great oceans in order to explain difficulties in the distribution of single genera or families; that geologists of repute have claimed the Dolphin bank in the Atlantic trough as the relic of a chain of mountains comparable with the Andes; that oceanic islands have been recently claimed to be merely the tops of submerged mountains, which can only be properly compared with the highest points of continents, and that a geological critic so late as 1879 considered the idea that the oceans had always been in their present positions "a funny one." If such extreme views are now less common than they were, I hope that I may, without presumption, claim to have had some share in bringing about the change in scientific opinion now in progress.

ALFRED R. WALLACE.

MUSEUMS AND SPECIALISTS.

I DESIRE to raise a slight objection to the kindly notice of my account of the Fossil Crinoids in the British Museum (NATURAL SCIENCE, vol. i., p. 474), a notice that has just been reprinted verbatim in the *American Geologist* for October. It is stated that I accept as my rule the American maxim, that a museum is a collection of labels illustrated by specimens; but this gives an entirely erroneous impression. The paper referred to began with Professor Flower's words, "a well-arranged *educational* Museum has been defined as a collection, &c.," and it further stated in so many words that it dealt solely with the specimens exhibited for the diffusion of scientific knowledge.

The excuse for this protest is that the comments appeared shortly after a leading article on a similar subject, in which comparisons were instituted between the Storehouse-type of museum, disarranged and thick in dust, with its keys half

lost, and the Text-book type of Museum, with little exhibited but that little in perfect order, to the great disadvantage of the latter. Now, that article was certainly entertaining and contained a few pointed truths, but at the same time its bearing is not quite clear.

No museum yet built can possibly exhibit every specimen it contains, or ought to contain; and no rational zoologist, when he visits a foreign museum, expects to see all the individuals of his particular group set out (in dust or otherwise) under glass cases. Selection is a necessity, and this being so, it may as well be done on the best principles, and with the intention of interesting or instructing the majority of visitors to the museum, by whom, in many cases, and not by the "poor zoologist," the museum is, in fact, supported. As for the specialist, surely it is more to his convenience that the collection he wishes to examine should be kept in drawers, in perfect order and not dusty, so that the specimens can at once be taken out without disarranging the show-cases, and without giving more than five minutes' trouble to an attendant. Even when specimens are set out under glass, it appears, from the article in question, that the visitor must have the cases unlocked to be able to see them. Were the specimens in drawers and properly catalogued they could be found in less time than the unaided visitor would take to find them in his walk round. The article was obviously written by one who had suffered; let me remind him that the specialist visitors to a museum are in a very great minority, and let me suggest that next time he purposes visiting a museum with only one curator he should write and make arrangements beforehand.

F. A. Bather.

The Parasites of Cut Corks.

I shall be extremely grateful if some reader will kindly inform me what parasites, including fungi (if any), specially attack and destroy *cut* corks, as used, for example, in the manufacture of floats for fishing nets, for life-belts, and life-buoys, of course often immersed for long periods in fresh and in salt waters.

Many of these life-saving appliances are covered with painted coarse canvas.

The cork floats of fishing nets, with the nets, are boiled together in a solution of oak bark at intervals of about every three weeks. Other fishermen use catechu, tar, tannin, &c., and in Japan the unripe juice of persimmons (*Diospyrus virginiana*).

I am not aware that these corks are usually *superficially waterproofed*, for which process I am anxious to learn what materials are best suited. It is evident that such waterproof materials should be as light as possible, having a specific gravity less than that of fresh water, so as not to diminish the buoyancy of the cork used.

Both the Board of Trade and the Lifeboat Institution recommend that only *solid* cork should be employed for this work in the rescue of the drowning.

I should be further indebted for a complete list of aquatic animals and plants which attack corks long immersed or sunk in salt water and in fresh water.

I am also anxious to obtain specimens of old or "rotten" corks which have lost their powers of buoyancy in salt water, especially any which may sink more or less in water, with a view to exhibit these at the Royal Cornish Fisheries, (1893) Exhibition, of which I am one of the vice-presidents.

J. Lawrence Hamilton, M.R.C.S.

30 Sussex Square, Brighton.

Second Wind.

Second wind is due to the power of the respiratory centre to suddenly adapt itself to modified or changed circumstances and conditions. The respiratory centre is the nervous mechanism which presides over and guides the movements of respiration It is acted upon or influenced by stimuli reaching it from the respiratory muscles, the lung substance, and the blood circulating in and around the respiratory centre in the *medulla oblongata* (or the basal portion of the brain, which adjoins the spinal cord)

Any alteration in the composition of the blood will naturally react upon

this respiratory centre. Hence, by some physiologists breathlessness has been attributed to an undue proportion or excess of carbonic acid in the blood. To explain the phenomena of Second Wind, some writers have alleged that the respiratory centre can become accustomed to the increased amount of carbonic acid present—a condition which has been observed in many human diseases.

As regards deep-sea fishing, rushing the animal upwards and making the fish thus breathless, is due partly to fright, but still more to altered "atmospheric" and aquatic pressures, which cause the contained gases, including the carbonic acid, within the fish to expand and escape in increasing proportions. Evidently the nearer the hooked and suddenly-raised fish is drawn to the surface, the less is the amount of carbonic acid included within the animal's blood; its breathlessness is nevertheless augmented, thus clearly illustrating that extreme breathlessness may exist with a diminished and diminishing supply of carbonic acid. This fact seems to suggest that some cases of breathlessness may be explained on other grounds than those due to a supposed excess of carbonic acid in the blood.

I am anxious to learn whether domesticated and wild animals, especially those which are chased or hunted, have been observed to suffer from phenomena similar to those experienced in the so-styled second wind of man, which appears to be analogous to the so-called "blowing" of horses and hounds.

J. Lawrence Hamilton, M.R.C.S.

TO CORRESPONDENTS.

All communications for the Editor *to be addressed to the* Editorial Offices, 67–69 *Chancery Lane, London, W.C.*

M. Suchetet (*Bréauté, near Goderville, Seine-Inférieure, France*) is studying the facts and principles of hybridisation, and invites the co-operation of naturalists who can favour him with observations.

W. James (Liverpool).—The feathers of *Dinornis* were first described by W. S. Dallas, *Proc. Zool. Soc.*, 1865, p. 265, and *Ann. Mag. Nat. Hist.*, vol. xvi. (1865), p. 66.

J. L. R. (Northampton).—The references are unnecessary. Professor Cope's views on Evolution are summarised in his work "The Origin of the Fittest," published by Appleton, 1887.

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The Great Barrier Reef of Australia, represented by a vast rampart of coral origin, extending for no less a length than twelve hundred miles from Torres Straits to Lady Elliot Island on the Queensland coast, takes rank among the most notable of the existing wonders of the world. Built up by the direct and indirect agency of soft-fleshed polyps of multitudinous form and colour, it encloses betwixt its outer border and the adjacent mainland a tranquil ocean highway for vessels of the heaviest draught; while from within and among its intricate channels and archipelagoes of semi-submerged reefs and islets, commercial wealth, as from an exhaustless gold mine, is perennially extracted. To the naturalist, and more particularly to the marine biologist, the entire Barrier area is a perfect Eldorado, its prolific waters teeming with animal organisms of myriad form and hue representative of every marine zoological group.

The scope of the projected work will be to render an account, in clear and popular language, of the most highly attractive subjects from a commercial and biological standpoint that are associated with the Barrier Region, and, in the former connection, more especially to indicate the lines on which, through the application of scientific methods, more remunerative returns even than heretofore are to be realised. In this particular direction the majority of the Australian Colonies, including all those bordering on tropical waters, and those holding, as is the case with New South Wales, a substantial stake in the Great Barrier Fisheries (the Torres Straits Pearl-Shell Fisheries are mainly worked by Sydney capitalists), will be more or less directly interested.

The author's qualifications for the task he undertakes are emphasised through the circumstance of his having been occupied for the past eight years as Inspector and Commissioner of Fisheries to various of the Australian Colonies, the three later years having been devoted more exclusively to investigating and reporting to the Queensland Government upon the fishery products of the Great Barrier District.

A prominent feature in this work will consist of photographic views of coral reefs of various construction and from diverse selected localities, together with similar and also coloured illustrations and descriptions of the living corolla, coral-polyps, and other marine organisms commonly associated on the reefs. These photographic illustrations taken by the author are, from both a scientific and an artistic standpoint, of high intrinsic merit and also unique in character, representing, in point of fact, the first occasion on which the camera has been employed for the systematic delineation of these subjects. It is, moreover, only at exceptionally rare and uncertain intervals that the coral reefs are uncovered to the extent in which in many instances Mr Saville-Kent has succeeded in depicting them. This section of the work should prove specially attractive to both the biologist and nature-admiring public generally, who will for the first time be made familiar with the natural aspect of these most remarkable organic productions.

The popular conception of reef corals has hitherto been associated mainly with the bleached skeletons, beautiful objects in themselves, that are imported in sparing quantities chiefly for museum collections, and concerning which, in even these advanced days of scientific culture, the erroneous idea still widely prevails that its fabricators are represented by a species of so-called coral insect, that holds the same relation to its associated coral as subsists between a bee and its waxen cell. The data and profuse illustrations in course of preparation, portraying innumerable varieties of coral structures under their natural conditions, should contribute substantially towards their more correct comprehension by the public mind, and in this direction fulfil a useful educational function.

The leading fishing industries of the Barrier District will necessarily occupy an important position in the forthcoming work. These fisheries include more notably those of the Pearl and Pearl-Shell, and Bêche-de-Mer, or Trepang, the conjoined annual value of the raw products of which, as shipped from Queensland ports, exceeds £150,000. In connection with the Pearl and Pearl-Shell Fisheries, full particulars will be recorded concerning the successful experiments conducted by the author at Thursday Island, Torres Straits, in the direction of artificially cultivating the Mother-of-Pearl shell (*Meleagrina Margaritifera*), and the results of which experiments are calculated to develop a new and profitable branch of the pearl-shelling industry throughout those areas in Australian and other waters fitted for the growth of this valuable mollusk.

The Bêche-de-Mer, or Trepang Fishery, in addition to its graphic description, will be illustrated by a series of photographs depicting the animals as they naturally occur on the reefs, and the processes of preparing them for the Chinese Market. The Bêche-de-Mer collected on the Great Barrier Reef, and known as "Barrier" or "Queensland Fish," obtains the highest market price that is given, and this important fishery undoubtedly presents a wide field for a yet more extended and profitable development on lines that will be indicated in the forthcoming work.

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